



Digi XBee® Cellular 3G Global

Embedded Modem

User Guide

Revision history—90001541

Revision	Date	Description
AA	November 2022	Updated to include a link to the Digi MicroPython Programming Guide. See PY (MicroPython Command) . Updated DT (Cellular Network Time) .
AB	January 2023	Added Digi Remote Manager device requests section: Device Requests in Remote Manager .
AC	July 2023	▪ Updated PY (MicroPython Command) to include PYR (Soft Reset). ▪ Updated default value for K1 and K2 AT commands.
AD	May 2025	Added Bluetooth DTM protocol for x1C and later. Fixed Calculate Checksum calculations.
AE	June 2026	Updated to be in line with Bluetooth® SIG branding guidelines: changed references from "BLE" to "Bluetooth® Low Energy (LE)," verified all instances of "Bluetooth" included the registered trademark and are uppercase, removed any instances of "-enabled." Replaced all references to XCTU with XBee Studio.

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Product serial number (s)
Firmware version
Operating system/browser (if applicable)
Logs (from time of reported issue)
Trace (if possible)
Description of issue
Steps to reproduce

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The XBee Cellular Modem integrates an embedded Wideband Code Division Multiple Access (WCDMA) cellular module and enables original equipment manufacturers (OEMs) to incorporate 3G cellular technology into their devices and applications without painful, time-consuming, and expensive FCC and carrier end-device certifications.

With the full suite of standard XBee API frames and AT commands, existing XBee customers can seamlessly transition to this new device with only minor software adjustments. When OEMs add the XBee Cellular Modem to their product, they create a future-proof design with flexibility to switch between wireless protocols or frequencies as needed.

You can read some frequently asked questions [here](#).

Applicable firmware and hardware

This manual supports the following firmware:

- 113xx and above

Note This manual uses the placeholder value "xx" in the firmware versions listed above, as the manual documents the released features as of the time of its writing. Digi International periodically releases new firmware containing bug fixes and new features. As new firmware is released and distributor stock is refreshed, the new firmware will gradually become available without the need to update. However, no guarantees can be made that a specific version of the firmware will be populated on any given XBee as delivered. If a specific revision is desired, it is the user's responsibility to ensure that version is loaded onto all XBees purchased.

Note You must upgrade your device to the latest firmware for all features to be available. See [Update the firmware](#).

The documentation supports the following hardware.

- XBC-M5-UT-xxx

Safety instructions

Safety instructions

XBee adapter, gateways, and routers

- The XBee Adapter, Gateway, or Router products cannot be guaranteed operation due to the radio link and so should not be used for interlocks in safety critical devices such as machines or automotive applications.
- The XBee Adapter, Gateway, or Router products have not been approved for use in (this list is not exhaustive):
 - medical devices
 - nuclear applications
 - explosive or flammable atmospheres
- There are no user serviceable components inside the XBee Adapter, Gateway, or Router product. Do not remove the product covers or modify the Gateway or Router in any way. Modifications may exclude the product from any warranty and can cause the gateway or router to operate outside of regulatory compliance for a given country, leading to the possible illegal operation of the product.
- Use industry standard Electrostatic Discharge (ESD) protection when handling the XBee Adapter, Gateway, or Router product.
- Take care while handling to avoid electrical damage to the PCB and components.
- Do not expose the XBee Adapter, Gateway, or Router products to water or moisture.
- Use this product with the antennas specified in the XBee Adapter, Gateway, or Router product user guides.
- The end user must be told how to remove power from the XBee Adapter, Gateway, or Router product or to locate the antennas 20 cm from humans or animals.

Инструкции за безопасност

XBee модули

- Радио модулят XBee не може да бъде гарантиран за работа поради радиовръзката и затова не трябва да се използва за блокировки в критични за безопасността устройства като машини или автомобилни приложения.
- Радио модулят XBee не е одобрен за използване в (този списък не е изчерпателен):
 - медицински изделия
 - ядрени приложения
 - експлозивна или запалима атмосфера
- В радиомодула XBee няма компоненти, които могат да се обслужват от потребителя. Не премахвайте щита и не модифицирайте XBee по никакъв начин. Модификациите могат да изключат модула от всякаква гаранция и да накарат радиото XBee да работи извън регулаторното съответствие за дадена държава, което води до

възможна незаконна работа на радиото.

- Използвайте стандартна ESD защита при работа с XBee модула.
- Внимавайте, докато боравите, за да избегнете електрически повреди на печатната платка и компонентите.
- Не излагайте радиомодулите XBee на вода или влага.
- Използвайте този продукт с антените, посочени в ръководствата за потребителя на модула XBee.
- Крайният потребител трябва да бъде казано как да премахне захранването от радиомодула XBee или да разположи антените на 20 см от хора или животни.

Sigurnosne upute

XBee moduli

- Radio modulu XBee ne može se jamčiti rad zbog radio veze i stoga se ne smije koristiti za blokade u sigurnosnim kritičnim uređajima kao što su strojevi ili automobilske aplikacije.
- XBee radio modul nije odobren za upotrebu u (ovaj popis nije konačan):
 - medicinskih uređaja
 - nuklearne primjene
 - eksplozivne ili zapaljive atmosfere
- Unutar XBee radio modula nema komponenti koje može servisirati korisnik. Nemojte uklanjati štit i ni na koji način modificirati XBee. Izmjene mogu isključiti modul iz bilo kakvog jamstva i mogu uzrokovati rad XBee radija izvan usklađenosti s propisima za određenu zemlju, što može dovesti do mogućeg nezakonitog rada radija.
- Koristite standardnu ESD zaštitu pri rukovanju XBee modulom.
- Budite oprezni tijekom rukovanja kako biste izbjegli električna oštećenja PCB-a i komponenti.
- Ne izlažite XBee radio module vodi ili vlazi.
- Koristite ovaj proizvod s antenama navedenim u korisničkim vodičima za XBee modul.
- Krajnjem korisniku se mora reći kako da isključi napajanje iz XBee radio modula ili da locira antene 20 cm od ljudi ili životinja.

Bezpečnostní instrukce

moduly XBee

- Rádiový modul XBee nemůže zaručit provoz kvůli rádiovému spojení, a proto by neměl být používán pro blokování v zařízeních kritických z hlediska bezpečnosti, jako jsou stroje nebo automobilové aplikace.
- Rádiový modul XBee nebyl schválen pro použití v (tento seznam není vyčerpávající):
 - zdravotnické prostředky
 - jaderné aplikace
 - výbušné nebo hořlavé atmosféry

- Uvnitř rádiového modulu XBee nejsou žádné uživatelsky opravitelné součásti. Neodstraňujte štít ani nijak neupravujte XBee. Úpravy mohou vyjmout modul z jakékoli záruky a mohou způsobit, že rádio XBee bude fungovat mimo zákonnou shodu pro danou zemi, což povede k možnému nezákonnému provozu rádia.
- Při manipulaci s modulem XBee používejte standardní ochranu ESD.
- Při manipulaci buďte opatrní, aby nedošlo k elektrickému poškození desky plošných spojů a součástí.
- Nevystavujte rádiové moduly XBee vodě nebo vlhkosti.
- Používejte tento produkt s anténami uvedenými v uživatelských příručkách modulu XBee.
- Koncový uživatel musí být informován, jak odpojit napájení rádiového modulu XBee nebo jak umístit antény 20 cm od lidí nebo zvířat.

Sikkerhedsinstruktioner

XBee moduler

- XBee-radiomodulet kan ikke garanteres drift på grund af radioforbindelsen og bør derfor ikke bruges til aflåsninger i sikkerhedskritiske enheder såsom maskiner eller bilapplikationer.
- XBee-radiomodulet er ikke godkendt til brug i (denne liste er ikke udtømmende):
 - medicinsk udstyr
 - nukleare applikationer
 - eksplosive eller brandfarlige atmosfærer
- Der er ingen komponenter, der kan repareres af brugeren, inde i XBee-radiomodulet. Fjern ikke skjoldet eller modificer XBee på nogen måde. Ændringer kan udelukke modulet fra enhver garanti og kan få XBee-radioen til at fungere uden for lovgivningsoverholdelse for et givet land, hvilket kan føre til den mulige ulovlige drift af radioen.
- Brug industristandard ESD-beskyttelse, når du håndterer XBee-modulet.
- Vær forsigtig under håndteringen for at undgå elektrisk beskadigelse af printet og komponenterne.
- Udsæt ikke XBee-radiomoduler for vand eller fugt.
- Brug dette produkt med de antenner, der er specificeret i XBee-modulets brugervejledninger.
- Slutbrugeren skal fortælles, hvordan man fjerner strømmen fra XBee-radiomodulet eller placerer antennerne 20 cm fra mennesker eller dyr.

Veiligheidsinstructies

XBee-modules

- De werking van de XBee-radiomodule kan niet worden gegarandeerd vanwege de radioverbinding en mag daarom niet worden gebruikt voor vergrendelingen in veiligheidskritieke apparaten zoals machines of autotoepassingen.
- De XBee-radiomodule is niet goedgekeurd voor gebruik in (deze lijst is niet uitputtend):

- o medische apparaten
 - o nucleaire toepassingen
 - o explosieve of ontvlambare atmosferen
- Er zijn geen door de gebruiker te onderhouden componenten in de XBee-radiomodule. Verwijder het schild niet en wijzig de XBee op geen enkele manier. Modificaties kunnen de module uitsluiten van enige garantie en kunnen ertoe leiden dat de XBee-radio werkt buiten de regelgeving voor een bepaald land, wat kan leiden tot de mogelijke illegale werking van de radio.
 - Gebruik industriestandaard ESD-bescherming bij het hanteren van de XBee-module.
 - Wees voorzichtig bij het hanteren om elektrische schade aan de printplaat en componenten te voorkomen.
 - Stel XBee-radiomodule niet bloot aan water of vocht.
 - Gebruik dit product met de antennes die zijn gespecificeerd in de gebruikershandleidingen van de XBee-module.
 - De eindgebruiker moet worden verteld hoe de voeding van de XBee-radiomodule moet worden losgekoppeld of hoe de antennes op 20 cm van mensen of dieren moeten worden geplaatst.

Ohutusjuhised

XBee moodulid

- XBee raadiomooduli tööd ei saa raadiolingi tõttu garanteerida ja seetõttu ei tohiks seda kasutada ohutuse seisukohalt oluliste seadmete (nt masinad või autorakendused) blokeerimiseks.
- XBee raadiomoodulit ei ole heaks kiidetud kasutamiseks (see loetelu ei ole ammendav):
 - meditsiiniseadmed
 - tuumarakendused
 - plahvatusohtlik või tuleohtlik keskkond
- XBee raadiomoodulis ei ole kasutaja poolt hooldatavaid komponente. Ärge eemaldage kaitset ega muutke XBee mingil viisil. Muudatused võivad mooduli garantiist välja jätta ja XBee raadio töötab väljaspool antud riigi regulatiivseid vastavusi, põhjustades raadio võimaliku ebaseadusliku kasutamise.
- Kasutage XBee mooduli käsitlemisel tööstusharu standardset ESD-kaitset.
- Olge käsitlemisel ettevaatlik, et vältida PCB ja komponentide elektrikahjustusi.
- Ärge jätke XBee raadiomoduleid vee või niiskuse kätte.
- Kasutage seda toodet XBee mooduli kasutusjuhendis kirjeldatud antennidega.
- Lõppkasutajale tuleb öelda, kuidas XBee raadiomoodulilt toide eemaldada või antennid inimestest või loomadest 20 cm kaugusele paigutada.

Turvallisuusohjeet

XBee moduulit

- XBee-radiomoduulin toimintaa ei voida taata radiolinkin vuoksi, joten sitä ei tule käyttää turvallisuuden kannalta kriittisten laitteiden, kuten koneiden tai autosovellusten, lukitsemiseen.
- XBee-radiomoduulia ei ole hyväksytty käytettäväksi (tämä luettelo ei ole tyhjentävä):
 - lääketieteelliset laitteet
 - ydinvoimasovellukset
 - räjähdysvaarallisiin tai syttyviin tiloihin
- XBee-radiomoduulin sisällä ei ole käyttäjän huollettavia osia. Älä poista suojusta tai muokkaa XBeetä millään tavalla. Muutokset voivat sulkea moduulin takuun ulkopuolelle ja aiheuttaa sen, että XBee-radio toimii tietyn maan säädöstenmukaisuuden ulkopuolella, mikä johtaa radion mahdolliseen laittomaan käyttöön.
- Käytä alan standardia ESD-suojausta käsitellessäsi XBee-moduulia.
- Ole varovainen käsitellessäsi, jotta vältät piirilevyn ja komponenttien sähkövauriot.
- Älä altista XBee-radiomoduuleja vedelle tai kosteudelle.
- Käytä tätä tuotetta XBee-moduulin käyttöoppaissa määriteltujen antennien kanssa.
- Loppukäyttäjälle on kerrottava, kuinka XBee-radiomoduulin virta katkaistaan tai antennit sijoitetaan 20 cm:n etäisyydelle ihmisistä tai eläimistä.

Consignes de sécurité

Modules XBee

- Le fonctionnement du module radio XBee ne peut pas être garanti en raison de la liaison radio et ne doit donc pas être utilisé pour les verrouillages dans des dispositifs critiques pour la sécurité tels que des machines ou des applications automobiles.
- Le module radio XBee n'a pas été approuvé pour une utilisation dans (cette liste n'est pas exhaustive) :
 - dispositifs médicaux
 - applications nucléaires
 - atmosphères explosives ou inflammables
- Il n'y a aucun composant réparable par l'utilisateur à l'intérieur du module radio XBee. Ne retirez pas la protection et ne modifiez en aucune façon le XBee. Les modifications peuvent exclure le module de toute garantie et peuvent entraîner le fonctionnement de la radio XBee en dehors de la conformité réglementaire pour un pays donné, ce qui peut entraîner un fonctionnement illégal de la radio.
- Utilisez la protection ESD standard de l'industrie lors de la manipulation du module XBee.
- Soyez prudent lors de la manipulation afin d'éviter des dommages électriques au circuit imprimé et aux composants.
- N'exposez pas les modules radio XBee à l'eau ou à l'humidité.

- Utilisez ce produit avec les antennes spécifiées dans les guides d'utilisation du module XBee.
- L'utilisateur final doit savoir comment couper l'alimentation du module radio XBee ou placer les antennes à 20 cm des humains ou des animaux.

Sicherheitshinweise

XBee-Module

- Der Betrieb des XBee-Funkmoduls kann aufgrund der Funkverbindung nicht garantiert werden und sollte daher nicht für Verriegelungen in sicherheitskritischen Geräten wie Maschinen oder Automobilanwendungen verwendet werden.
- Das XBee-Funkmodul ist nicht zugelassen für den Einsatz in (diese Liste ist nicht vollständig):
 - Medizinprodukte
 - nukleare Anwendungen
 - explosive oder brennbare Atmosphären
- Das XBee-Funkmodul enthält keine vom Benutzer zu wartenden Komponenten. Entfernen Sie nicht die Abschirmung oder modifizieren Sie das XBee in irgendeiner Weise. Modifikationen können das Modul von jeglicher Garantie ausschließen und dazu führen, dass das XBee-Funkgerät außerhalb der gesetzlichen Vorschriften für ein bestimmtes Land betrieben wird, was zu einem möglichen illegalen Betrieb des Funkgeräts führen kann.
- Verwenden Sie beim Umgang mit dem XBee-Modul ESD-Schutz nach Industriestandard.
- Seien Sie vorsichtig bei der Handhabung, um elektrische Schäden an der Leiterplatte und den Komponenten zu vermeiden.
- XBee-Funkmodule nicht Wasser oder Feuchtigkeit aussetzen.
- Verwenden Sie dieses Produkt mit den in den Benutzerhandbüchern des XBee-Moduls angegebenen Antennen.
- Dem Endbenutzer muss mitgeteilt werden, wie er das XBee-Funkmodul von der Stromversorgung trennt oder die Antennen 20 cm von Menschen oder Tieren entfernt aufstellt.

Οδηγίες ασφαλείας

Μονάδες XBee

- Η μονάδα ραδιοφώνου XBee δεν μπορεί να εγγυηθεί τη λειτουργία της λόγω της ραδιοζεύξης και επομένως δεν πρέπει να χρησιμοποιείται για ασφάλειες σε κρίσιμες για την ασφάλεια συσκευές, όπως μηχανήματα ή εφαρμογές αυτοκινήτου.
- Η μονάδα ραδιοφώνου XBee δεν έχει εγκριθεί για χρήση σε (αυτή η λίστα δεν είναι εξαντλητική):
 - ιατροτεχνολογικά προϊόντα
 - πυρηνικές εφαρμογές
 - εκρηκτικές ή εύφλεκτες ατμόσφαιρες

- Δεν υπάρχουν εξαρτήματα που να μπορούν να επισκευαστούν από το χρήστη μέσα στη μονάδα ραδιοφώνου XBee. Μην αφαιρείτε την ασπίδα και μην τροποποιείτε το XBee με κανέναν τρόπο. Οι τροποποιήσεις ενδέχεται να αποκλείουν τη μονάδα από οποιαδήποτε εγγύηση και μπορεί να προκαλέσουν τη λειτουργία του ραδιοφώνου XBee εκτός της συμμόρφωσης με τους κανονισμούς για μια δεδομένη χώρα, οδηγώντας σε πιθανή παράνομη λειτουργία του ραδιοφώνου.
- Χρησιμοποιήστε βιομηχανική προστασία ESD κατά το χειρισμό της μονάδας XBee.
- Προσέχετε κατά το χειρισμό για να αποφύγετε ηλεκτρική βλάβη στο PCB και στα εξαρτήματα.
- Μην εκθέτετε τις μονάδες ραδιοφώνου XBee σε νερό ή υγρασία.
- Χρησιμοποιήστε αυτό το προϊόν με τις κεραίες που καθορίζονται στους οδηγούς χρήσης της μονάδας XBee.
- Πρέπει να ενημερωθεί ο τελικός χρήστης πώς να αφαιρέσει την τροφοδοσία από τη μονάδα ραδιοφώνου XBee ή να εντοπίσει τις κεραίες σε απόσταση 20 cm από ανθρώπους ή ζώα.

Biztonsági utasítások

XBee modulok

- Az XBee rádiómodul működése nem garantálható a rádiókapcsolat miatt, ezért nem használható biztonsági szempontból kritikus eszközök, például gépek vagy autóiipari alkalmazások reteszelésére.
- Az XBee rádiómodul nem engedélyezett a következő területeken való használatra (ez a lista nem teljes):
 - orvosi eszközök
 - nukleáris alkalmazások
 - robbanásveszélyes vagy gyúlékony légkör
- Az XBee rádiómodulban nincsenek felhasználó által javítható alkatrészek. Ne távolítsa el a pajzsot, és semmilyen módon ne módosítsa az XBee-t. A módosítások kizárhatják a modult a jótállásból, és az XBee rádió működését az adott ország jogszabályi előírásaitól eltérően okozhatják, ami a rádió esetleges illegális működéséhez vezethet.
- Az XBee modul kezelésekor használjon ipari szabványos ESD védelmet.
- A kezelés során ügyeljen arra, hogy elkerülje a PCB és az alkatrészek elektromos károsodását.
- Ne tegye ki az XBee rádiómodulokat víznek vagy nedvességnek.
- Használja ezt a terméket az XBee modul használati útmutatójában meghatározott antennákkal.
- A végfelhasználót tájékoztatni kell arról, hogyan távolítsa el az XBee rádiómodul áramellátását, vagy hogyan helyezze el az antennákat az emberektől vagy állatoktól 20 cm-re.

Istruzioni di sicurezza

Moduli XBee

- Il funzionamento del modulo radio XBee non può essere garantito a causa del collegamento radio e quindi non deve essere utilizzato per gli interblocchi in dispositivi critici per la sicurezza come macchine o applicazioni automobilistiche.
- Il modulo radio XBee non è stato approvato per l'uso in (questo elenco non è esaustivo):
 - dispositivi medici
 - applicazioni nucleari
 - atmosfere esplosive o infiammabili
- Non ci sono componenti riparabili dall'utente all'interno del modulo radio XBee. Non rimuovere lo scudo o modificare in alcun modo l'XBee. Le modifiche possono escludere il modulo da qualsiasi garanzia e possono causare il funzionamento della radio XBee al di fuori della conformità normativa per un determinato paese, portando al possibile funzionamento illegale della radio.
- Utilizzare la protezione ESD standard del settore durante la manipolazione del modulo XBee.
- Prestare attenzione durante la manipolazione per evitare danni elettrici al PCB e ai componenti.
- Non esporre i moduli radio XBee all'acqua o all'umidità.
- Utilizzare questo prodotto con le antenne specificate nelle guide per l'utente del modulo XBee.
- L'utente finale deve sapere come togliere l'alimentazione al modulo radio XBee o come posizionare le antenne a 20 cm da persone o animali.

Drošības instrukcijas

XBee moduli

- Radio moduļa XBee darbība nevar tikt garantēta radio savienojuma dēļ, tāpēc to nevajadzētu izmantot bloķēšanai drošības ziņā kritiskās ierīcēs, piemēram, mašīnās vai automobiļos.
- XBee radio modulis nav apstiprināts lietošanai (šis saraksts nav pilnīgs):
 - medicīniskās ierīces
 - kodolprogrammas
 - sprādzienbīstamā vai uzliesmojošā vidē
- XBee radio moduļa iekšpusē nav neviena komponenta, ko lietotājs varētu apkopt. Nenoņemiet vairogu un nekādā veidā nepārveidojiet XBee. Modifikācijas rezultātā modulis var tikt izslēgts no jebkādas garantijas un var izraisīt XBee radio darbību, kas neatbilst noteiktās valsts normatīvajiem aktiem, izraisot iespējamu nelegālu radio darbību.
- Strādājot ar XBee moduli, izmantojiet nozares standarta ESD aizsardzību.
- Rīkojoties, rīkojieties uzmanīgi, lai izvairītos no PCB un komponentu elektriskiem bojājumiem.
- Nepakļaujiet XBee radio moduļus ūdens vai mitruma iedarbībai.
- Izmantojiet šo izstrādājumu ar antenām, kas norādītas XBee moduļa lietotāja rokasgrāmatās.

- Galalietotājam ir jāpaskaidro, kā atvienot XBee radio moduļa strāvu vai novietot antenas 20 cm attālumā no cilvēkiem vai dzīvniekiem.

Saugos instrukcijas

XBee moduļi

- Negalima garantuoti, kad „XBee“ radijo modulis veiks dėl radijo ryšio, todėl jo neturėtų būti naudojamas blokuoti saugai svarbiuose įrenginiuose, pvz., mašinos ar automobiliuose.
- XBee radijo modulis nebuvo patvirtintas naudoti (šis sąrašas nėra baigtinis):
 - medicinos prietaisai
 - branduolinės programos
 - sprogioje ar degioje aplinkoje
- XBee radijo modulio viduje nėra komponentų, kuriuos vartotojas galėtų prižiūrėti. Jokių būdu nenuimkite skydo ir nekeiskite XBee. Dėl modifikacijų moduliui gali būti netaikoma jokia garantija, o „XBee“ radijas gali veikti ne pagal tam tikros šalies norminius reikalavimus, o tai gali sukelti neteisėtą radijo naudojimą.
- Dirbdami su XBee moduliu naudokite pramonės standartinę ESD apsaugą.
- Dirbdami būkite atsargūs, kad nepažeistumėte PCB ir komponentų.
- Saugokite XBee radijo modulius nuo vandens ar drėgmės.
- Naudokite šį gaminį su antenomis, nurodytomis XBee modulio vartotojo vadove.
- Galutiniam vartotojui turi būti paaiškinta, kaip atjungti XBee radijo modulio maitinimą arba nustatyti antenas 20 cm atstumu nuo žmonių ar gyvūnų.

Sikkerhetsinstruksjoner

XBee-moduler

- XBee-radiomodulen kan ikke garanteres drift på grunn av radiolinken, og bør derfor ikke brukes til forriglinger i sikkerhetskritiske enheter som maskiner eller bilapplikasjoner.
- XBee-radiomodulen er ikke godkjent for bruk i (denne listen er ikke uttømmende):
 - medisinsk utstyr
 - kjernefysiske applikasjoner
 - eksplosive eller brennbare atmosfærer
- Det er ingen komponenter som kan repareres av brukeren inne i XBee-radiomodulen. Ikke fjern skjoldet eller modifier XBee på noen måte. Endringer kan ekskludere modulen fra enhver garanti og kan føre til at XBee-radioen fungerer utenfor regelverket for et gitt land, noe som kan føre til ulovlig drift av radioen.
- Bruk industristandard ESD-beskyttelse når du håndterer XBee-modulen.
- Vær forsiktig ved håndtering for å unngå elektrisk skade på PCB og komponenter.
- Ikke utsett XBee radiomoduler for vann eller fuktighet.
- Bruk dette produktet med antennene spesifisert i XBee-modulens brukerveiledninger.

- Sluttbrukeren må bli fortalt hvordan man fjerner strømmen fra XBee-radiomodulen eller plasserer antennene 20 cm fra mennesker eller dyr.

Instrukcje bezpieczeństwa

Moduły XBee

- Moduł radiowy XBee nie może zagwarantować działania ze względu na łącze radiowe, dlatego nie należy go używać do blokad w urządzeniach o krytycznym znaczeniu dla bezpieczeństwa, takich jak maszyny lub aplikacje motoryzacyjne.
- Moduł radiowy XBee nie został dopuszczony do użytku w (lista ta nie jest wyczerpująca):
 - wyroby medyczne
 - zastosowania nuklearne
 - atmosferach wybuchowych lub łatwopalnych
- Wewnątrz modułu radiowego XBee nie ma żadnych elementów, które mogłyby być serwisowane przez użytkownika. Nie zdejmuj osłony ani nie modyfikuj XBee w żaden sposób. Modyfikacje mogą wykluczyć moduł z jakiegokolwiek gwarancji i spowodować, że radio XBee będzie działać niezgodnie z przepisami obowiązującymi w danym kraju, co może prowadzić do nielegalnego działania radia.
- Podczas obsługi modułu XBee należy stosować standardową ochronę ESD.
- Podczas obsługi należy zachować ostrożność, aby uniknąć uszkodzeń elektrycznych PCB i komponentów.
- Nie wystawiaj modułów radiowych XBee na działanie wody lub wilgoci.
- Używaj tego produktu z antenami określonymi w podręcznikach użytkownika modułu XBee.
- Użytkownik końcowy musi zostać poinformowany, jak odłączyć zasilanie modułu radiowego XBee lub zlokalizować anteny w odległości 20 cm od ludzi lub zwierząt.

Instruções de segurança

Módulos XBee

- O módulo de rádio XBee não pode ter operação garantida devido ao link de rádio e, portanto, não deve ser usado para intertravamentos em dispositivos críticos de segurança, como máquinas ou aplicações automotivas.
- O módulo de rádio XBee não foi aprovado para uso em (esta lista não é exaustiva):
 - o dispositivos médicos
 - o aplicações nucleares
 - o atmosferas explosivas ou inflamáveis
- Não há componentes que possam ser reparados pelo usuário dentro do módulo de rádio XBee. Não remova a blindagem nem modifique o XBee de forma alguma. As modificações podem excluir o módulo de qualquer garantia e fazer com que o rádio XBee opere fora da conformidade regulatória de um determinado país, levando à possível operação ilegal do rádio.
- Use proteção ESD padrão da indústria ao manusear o módulo XBee.

- Tome cuidado ao manusear para evitar danos elétricos à PCB e aos componentes.
- Não exponha os módulos de rádio XBee à água ou umidade.
- Use este produto com as antenas especificadas nos guias do usuário do módulo XBee.
- O usuário final deve ser informado sobre como remover a energia do módulo de rádio XBee ou localizar as antenas a 20 cm de humanos ou animais.

Instrucțiuni de siguranță

module XBee

- Nu se poate garanta funcționarea modului radio XBee din cauza conexiunii radio și, prin urmare, nu trebuie utilizat pentru interblocări în dispozitive critice pentru siguranță, cum ar fi mașini sau aplicații auto.
- Modulul radio XBee nu a fost aprobat pentru utilizare în (această listă nu este exhaustivă):
 - dispozitive medicale
 - aplicații nucleare
 - atmosfere explozive sau inflamabile
- Nu există componente care să poată fi reparate de utilizator în interiorul modului radio XBee. Nu îndepărtați scutul și nu modificați XBee în niciun fel. Modificările pot exclude modulul din orice garanție și pot face ca radioul XBee să funcționeze în afara conformității cu reglementările pentru o anumită țară, ceea ce duce la o posibilă funcționare ilegală a radioului.
- Folosiți protecția ESD standard în industrie când manipulați modulul XBee.
- Aveți grijă în timpul manipulării pentru a evita deteriorarea electrică a PCB-ului și a componentelor.
- Nu expuneți modulele radio XBee la apă sau umezeală.
- Utilizați acest produs cu antenele specificate în ghidurile utilizatorului modului XBee.
- Utilizatorului final trebuie să i se spună cum să scoată alimentarea de la modulul radio XBee sau să găsească antenele la 20 cm de oameni sau animale.

Bezpečnostné inštrukcie

moduly XBee

- Rádiový modul XBee nemôže byť zaručený kvôli rádiovému spojeniu, a preto by sa nemal používať na blokovanie v zariadeniach kritických z hľadiska bezpečnosti, ako sú stroje alebo automobilové aplikácie.
- Rádiový modul XBee nebol schválený na použitie v (tento zoznam nie je úplný):
 - zdravotnícke pomôcky
 - jadrové aplikácie
 - výbušné alebo horľavé atmosféry
- Vo vnútri rádiového modulu XBee sa nenachádzajú žiadne používateľsky opraviteľné komponenty. Neodstraňujte štít ani žiadnym spôsobom neupravujte XBee. Úpravy môžu

vyňať modul zo záruky a môžu spôsobiť, že rádio XBee bude fungovať mimo zhody s predpismi pre danú krajinu, čo vedie k nožnej nezákonnej prevádzke rádia.

- Pri manipulácii s modulom XBee používajte štandardnú ochranu pred ESD.
- Pri manipulácii buďte opatrní, aby ste predišli elektrickému poškodeniu dosky plošných spojov a komponentov.
- Rádiové moduly XBee nevystavujte vode ani vlhkosti.
- Tento produkt používajte s anténami špecifikovanými v používateľských príručkách modulu XBee.
- Koncový používateľ musí byť informovaný o tom, ako odpojiť napájanie rádiového modulu XBee alebo ako umiestniť antény 20 cm od ľudí alebo zvierat.

Varnostna navodila

XBee moduli

- Radijskega modula XBee ni mogoče zagotoviti delovanja zaradi radijske povezave in ga zato ne smete uporabljati za zaklepanje v varnostno kritičnih napravah, kot so stroji ali avtomobilске aplikacije.
- Radijski modul XBee ni bil odobren za uporabo v (ta seznam ni izčrpen):
 - medicinskih pripomočkov
 - jedrske aplikacije
 - eksplozivne ali vnetljive atmosfere
- V radijskem modulu XBee ni komponent, ki bi jih lahko popravil uporabnik. Ne odstranjujte ščita in na noben način ne spreminjajte XBee. Spremembe lahko modul izključijo iz kakršne koli garancije in lahko povzročijo, da radio XBee deluje zunaj zakonske skladnosti za dano državo, kar vodi do možnega nezakonitega delovanja radia.
- Pri ravnanju z modulom XBee uporabite standardno industrijsko zaščito pred ESD.
- Pri rokovanju pazite, da se izognete električnim poškodbam tiskanega vezja in komponent.
- Radijskih modulov XBee ne izpostavljajte vodi ali vlagi.
- Ta izdelek uporabljajte z antenami, navedenimi v uporabniških priročnikih modula XBee.
- Končnemu uporabniku je treba povedati, kako odstraniti napajanje z radijskega modula XBee ali naj locira antene 20 cm od ljudi ali živali.

Las instrucciones de seguridad

Módulos XBee

- No se puede garantizar el funcionamiento del módulo de radio XBee debido al enlace de radio y, por lo tanto, no debe usarse para enclavamientos en dispositivos críticos para la seguridad, como máquinas o aplicaciones automotrices.
- El módulo de radio XBee no ha sido aprobado para su uso en (esta lista no es exhaustiva):
 - dispositivos médicos
 - aplicaciones nucleares
 - atmósferas explosivas o inflamables

- No hay componentes reparables por el usuario dentro del módulo de radio XBee. No quite el escudo ni modifique el XBee de ninguna manera. Las modificaciones pueden excluir el módulo de cualquier garantía y pueden hacer que la radio XBee funcione fuera del cumplimiento normativo de un país determinado, lo que puede provocar una operación ilegal de la radio.
- Utilice la protección ESD estándar de la industria al manipular el módulo XBee.
- Tenga cuidado al manipularlo para evitar daños eléctricos en la PCB y los componentes.
- No exponga los módulos de radio XBee al agua ni a la humedad.
- Utilice este producto con las antenas especificadas en las guías de usuario del módulo XBee.
- Se debe indicar al usuario final cómo desconectar la alimentación del módulo de radio XBee o ubicar las antenas a 20 cm de personas o animales.

Säkerhets instruktioner

XBee-moduler

- XBee-radiomodulen kan inte garanteras funktion på grund av radiolänken och bör därför inte användas för förreglingar i säkerhetskritiska enheter som maskiner eller biltillämpningar.
- XBee-radiomodulen har inte godkänts för användning i (denna lista är inte uttömmande):
 - medicinsk utrustning
 - kärnkraftstillämpningar
 - explosiv eller brandfarlig atmosfär
- Det finns inga komponenter som användaren kan reparera inuti XBee-radiomodulen. Ta inte bort skölden eller modifiera XBee på något sätt. Ändringar kan utesluta modulen från alla garantier och kan göra att XBee-radion fungerar utanför bestämmelserna för ett visst land, vilket kan leda till att radion kan användas olagligt.
- Använd industristandard ESD-skydd när du hanterar XBee-modulen.
- Var försiktig vid hanteringen för att undvika elektriska skador på kretskortet och komponenterna.
- Utsätt inte XBee radiomoduler för vatten eller fukt.
- Använd den här produkten med antennerna som specificeras i XBee-modulens användarguider.
- Slut användaren måste informeras om hur man kopplar bort strömmen från XBee-radiomodulen eller för att placera antennerna 20 cm från människor eller djur.

SIM cards

The XBee Cellular Modem requires a 4FF nano-SIM card, which is the size normally used in most Smart phones. The SIM interface supports both 1.8 V and 3.3 V SIM types.

Cellular service

Digi now offers Cellular Bundled Service plans, where you can choose to purchase a subscription for cell service, and/or a Digi Remote Manager package.

To shop online, go to: shop.digi.com

To learn more, or obtain the plan that is right for your needs, contact us:

- By phone: 1-877-890-4014 (USA/toll free) or +1-952-912-3456 (International). Select the **Wireless Plan Support** or **Activation** option in the menu.
- By email: Data.Plan.QuoteDesk@digi.com.

Get started with the XBee Cellular Modem

This section describes how to connect the hardware in the XBee, and provides some examples you can use to communicate with the device.

You should perform all of the steps below in the order shown.

1. [Identify the kit contents](#)
2. [Connect the hardware](#)
3. [Install and upgrade XBee Studio](#)
4. Use one of the following methods to verify your cellular connection. You must have a SIM card installed.
 - [Connect to the Echo server](#)
 - [Connect to the ELIZA server](#)
 - [Connect to the Daytime server](#)

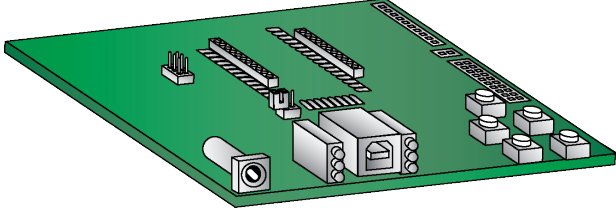
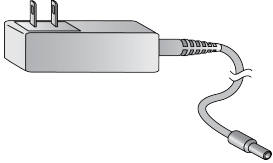
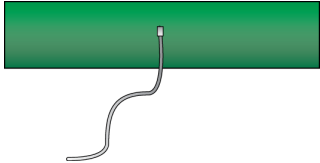
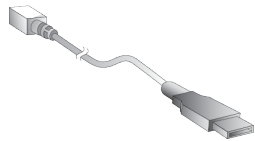
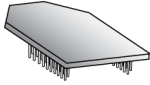
Optional steps

You can review the information in these steps for more XBee connection examples and examples of how to use MicroPython.

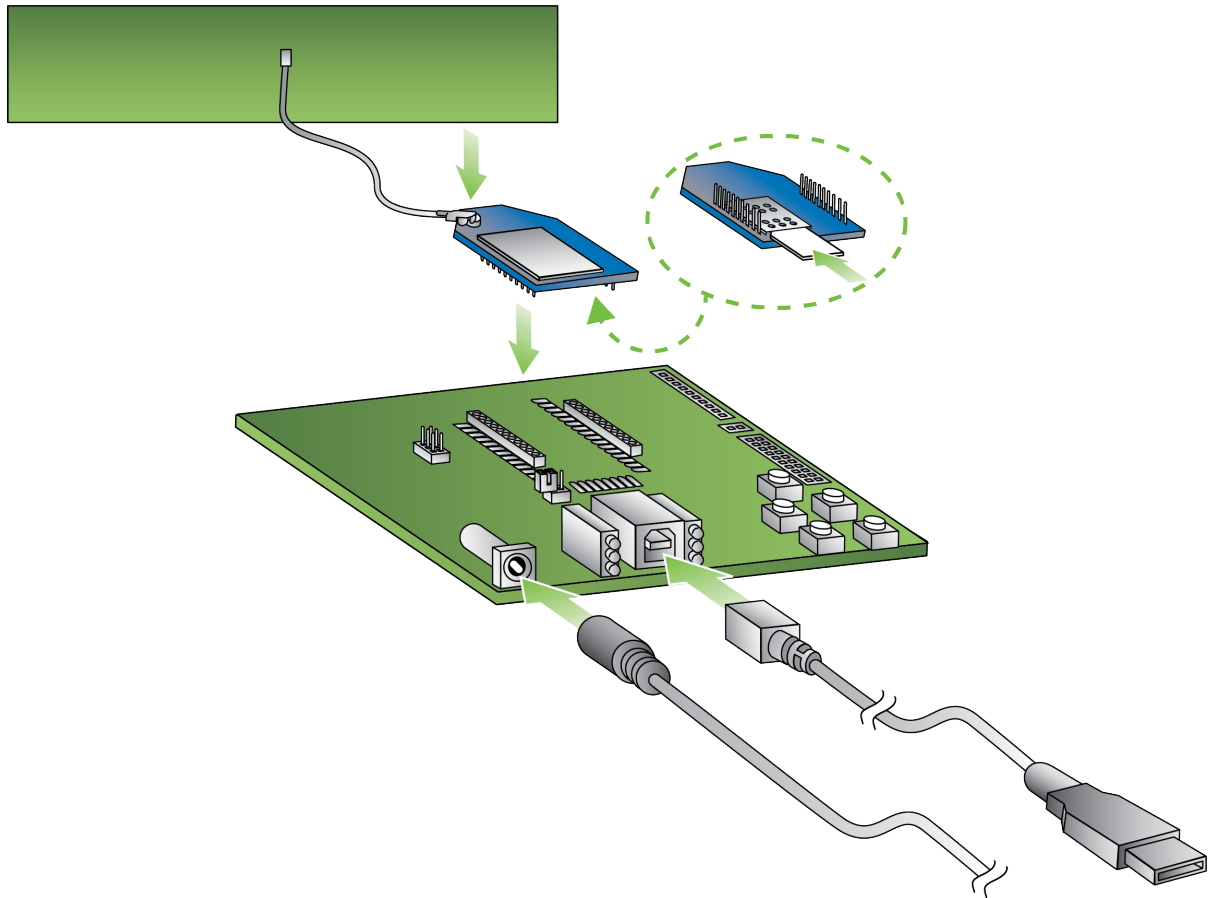
1. Review additional connection examples to help you learn how to use the device. See [XBee connection examples](#).
2. Review introductory MicroPython examples. You can use MicroPython to enhance the intelligence of the XBee to enable you to do edge-computing by adding business logic in MicroPython, rather than using external components.
 - [Example: hello world](#)
 - [Example: turn on an LED](#)

Identify the kit contents

The Developer's kit includes the following:

Item	Description
One XBIB-U-DEV board	
One 12 V power supply	
One cellular antenna with U.FL connector	
One USB cable	
One XBee Cellular Modem	
Note The XBee Cellular Modem comes attached to the board in ESD wrap.	
One SIM card	

Connect the hardware



1. The XBee Cellular Modem should already be plugged into the XBIB-U-DEV board. For more information about development boards, see [Development boards](#).
2. The SIM card should already be inserted into the XBee Cellular Modem. If not, install the SIM card into the XBee Cellular Modem.



WARNING! Never insert or remove the SIM card while the device is powered!



WARNING! The development board power supply only supports 3G mode. It does not support 2G mode.

3. Connect the antenna to the XBee Cellular Modem by aligning the U.FL connector carefully, then firmly pressing straight down to seat the connector. You should hear a snap when the antenna attaches correctly. U.FL is fragile and is not designed for multiple insertions, so exercise caution when connecting or removing the antennas. We recommend using a U.FL removal tool.
4. Plug the 12 V power supply to the power jack on the development board.

5. Connect the USB cable from a PC to the USB port on the development board. The computer searches for a driver, which can take a few minutes to install.

Install and upgrade XBee Studio

XBee Studio is a multi-platform program developed by Digi that enables users to interact with Digi radio frequency (RF) devices through a graphical interface. The application includes built-in tools that make it easy to set up, configure, and test Digi RF devices.

XBee Studio does not work directly over a serial peripheral interface (SPI).

You can use XBee Studio to update the device firmware. Firmware is the program code stored in the device's persistent memory that provides the control program for the device.

Note You cannot update the cellular component on a 3G device.

For instructions on downloading and using XBee Studio, see the [XBee Studio User Guide](#).

Note If you are on a macOS computer and encounter problems installing XBee Studio, see [Correct a macOS Java error](#).

Step 1: Install and upgrade XBee Studio

You can use XBee Studio to update the device firmware.

1. To use XBee Studio, you may need to install FTDI Virtual COM port (VCP) drivers onto your computer. Click [here](#) to download the drivers for your operating system.
2. [Upgrade XBee Studio](#) to the latest version. This step is required.

Step 2: Add a device to XBee Studio

Devices are added automatically. Once the device is detected, you can update the device's firmware or configure the device from XBee Studio.

For more information, see [Add a device](#) in the *XBee Studio User Guide*.

Update the device firmware using XBee Studio

You should use XBee Studio to update the device firmware on your XBee to the most recent version. This ensures that you can take advantage of all the latest fixes and features.

[Update the device firmware using XBee Studio](#).

Check for cellular registration and connection

The cellular network registration and address assignment must occur successfully. To verify the network connection, you can view the LED on the development board or check the status of the relevant commands in XBee Studio.

Registration can take several minutes.

Before you begin

- A working SIM card is required. See [Determine cellular service and acquire a SIM card](#).
- Make sure you have added the device to XBee Studio. See [Add a device](#).

- Make sure you are in an area with adequate cellular network reception.
- Verify that the antennas are connected properly to the device.

View LED action

The LED on the development board blinks when the XBee is registered to the cellular network; see [Associate LED functionality](#). If the LED remains solid, registration has not occurred properly.

View commands in XBee Studio

1. Launch XBee Studio .
2. Navigate to the device settings page by one of the following methods:
 - Hover over your device and then click **Open Settings**.
 - Click on your device and then click **Settings** in the left menu.
 - Click **Configuration** in the sidebar, then click **Settings**, then finally click on your device.
3. Verify the status of your network connection using the following commands:
 - **AI (Association Indication)** reads **0** when the device successfully registers to the cellular network and the LED is blinking. If it reads **23** it is connecting to the Internet; **22** means it is registering to the cellular network.
 - **MY (Module IP Address)** should display a valid IP address. If it reads **0.0.0.0**, it has not registered yet. Showing anything else means the device is registered.

Hints

- To search for an AT command in XBee Studio, use [the search box](#) .
- To read a command's value, click the **Read** button  next to the command.

XBee connection examples

The following examples provide some additional scenarios you can try to get familiar with the XBee. These examples are focused on inter-operating with a host processor to drive the XBee.

If you are interested in using the intelligence built into the XBee, see [Get started with MicroPython](#).

Note Some carriers restrict your internet access. If access is restricted, running some of these examples may not be possible. Check with your carrier provider to determine whether internet access is restricted.

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Connect to the Echo server

This server echoes back the messages you type.

Note For help with debugging, see [Debugging](#).

The following table explains the AT commands that you use in this example.

AT command	Value	Description
IP (IP Protocol)	1	Set the expected transmission mode to TCP communications.
TD (Text Delimiter)	D (0x0D)	The text delimiter to be used for Transparent mode, as an ASCII hex code. No information is sent until this character is entered, unless the maximum number of characters has been reached. Set to 0 to disable text delimiter checking. Set to D for a carriage return.
DL (Destination Address)	52.43.121.77	The target IP address of the echo server.
DE (Destination Port)	2329 (0x2329)	The target port number of the echo server.

To communicate with the Echo server:

1. Ensure that the device is set up correctly with the SIM card installed and the antennas connected as described in [Connect the hardware](#).
2. Open XBee Studio and [Add a device](#) (this should happen automatically).
3. Navigate to the device settings page by one of the following methods:
 - Hover over your device and then click **Open Settings**.
 - Click on your device and then click **Settings** in the left menu.
 - Click **Configuration** in the sidebar, then click **Settings**, then finally click on your device.
4. To switch to TCP communication, in the **IP** field, select 1 and click the **Write** button .
5. To enable the XBee to recognize carriage return as a message delimiter, in the **TD** field, type **D** and click the **Write** button.
6. To enter the destination address of the echo server, in the **DL** field, type **52.43.121.77** and click the **Write** button.
7. To enter the destination IP port number, in the **DE** field, type **2329** and click the **Write** button.

Note XBee Studio does not follow the standard hexadecimal numbering convention. The leading 0x is not needed in XBee Studio.

8. Navigate to the **XBee Console** by one of the following methods:

- Hover over your device and then click **Open Device Console**.
- Click on your device and then click **XBee Console** in the left menu.
- Click **Development** in the sidebar, then click **XBee Console**, then finally click on your device.

Note For instructions on using the Console, see the [XBee console](#) topic in the *XBee Studio User Guide*.

9. Click the **Open** button  to open a serial connection to the device.
10. Click the **Console log**, then type in the Console to talk to the echo server.

Connect to the ELIZA server

You can use the XBee to chat with the ELIZA Therapist Bot. ELIZA is an artificial intelligence (AI) bot that emulates a therapist and can perform simple conversations.

Note For help with debugging, see [Debugging](#).

The following table explains the AT commands that you use in this example.

At command	Value	Description
IP (IP Protocol)	1	Set the expected transmission mode to TCP communications.
DL (Destination Address)	52.43.121.77	The target IP address of the ELIZA server.
DE (Destination Port)	2328 (0x2328)	The target port number of the ELIZA server.

To communicate with the ELIZA Therapist Bot:

1. Ensure that the device is set up correctly with the SIM card installed and the antennas connected as described in [Connect the hardware](#).
2. Open XBee Studio and [Add a device](#) (this should happen automatically).
3. Navigate to the device settings page by one of the following methods:
 - Hover over your device and then click **Open Settings**.
 - Click on your device and then click **Settings** in the left menu.
 - Click **Configuration** in the sidebar, then click **Settings**, then finally click on your device.
4. To switch to TCP communication, in the **IP** field, select 1 and click the **Write** button .
5. To enter the destination address of the ELIZA Therapist Bot, in the **DL** field, type **52.43.121.77** and click the **Write** button.
6. To enter the destination IP port number, in the **DE** field, type **2328** and click the **Write** button.
7. Navigate to the **XBee Console** by one of the following methods:

- Hover over your device and then click **Open Device Console**.
- Click on your device and then click **XBee Console** in the left menu.
- Click **Development** in the sidebar, then click **XBee Console**, then finally click on your device.

Note For instructions on using the Console, see the [XBee console](#) topic in the *XBee Studio User Guide*.

8. Click the **Open** button  to open a serial connection to the device.
9. Click the **Console log**, then type in the Console to talk to the ELIZA Therapist Bot.

Connect to the Daytime server

The Daytime server reports the current Coordinated Universal Time (UTC) value responding to any user input.

Note For help with debugging, see [Debugging](#).

The following table explains the AT commands that you use in this example.

At command	Value	Description
IP (IP Protocol)	1	Set the expected transmission mode to TCP communications.
DL (Destination Address)	52.43.121.77	The target IP of the Daytime server.
DE (Destination Port)	232A (0x232A)	The target port number of the Daytime server.
TD (Text Delimiter)	0	The text delimiter to be used for Transparent mode, as an ASCII hex code. No information is sent until this character is entered, unless the maximum number of characters has been reached. Set to zero to disable text delimiter checking.

To communicate with the Daytime server:

1. Ensure that the device is set up correctly with the SIM card installed and the antennas connected as described in [Connect the hardware](#).
2. Open XBee Studio and [Add a device](#) (this should happen automatically).
3. Navigate to the device settings page by one of the following methods:
 - Hover over your device and then click **Open Settings**.
 - Click on your device and then click **Settings** in the left menu.
 - Click **Configuration** in the sidebar, then click **Settings**, then finally click on your device.
4. To switch to TCP communication, in the **IP** field, select 1 and click the **Write** button .

5. To enter the destination address of the daytime server, in the **DL** field, type **52.43.121.77** and click the **Write** button.
6. To enter the destination IP port number, in the **DE** field, type **232A** and click the **Write** button.
7. To disable text delimiter checking, in the **TD** field, type **0** and click the **Write** button.
8. Navigate to the **XBee Console** by one of the following methods:
 - Hover over your device and then click **Open Device Console**.
 - Click on your device and then click **XBee Console** in the left menu.
 - Click **Development** in the sidebar, then click **XBee Console**, then finally click on your device.

Note For instructions on using the Console, see the [XBee console](#) topic in the *XBee Studio User Guide*.

9. Click the **Open** button  to open a serial connection to the device.
10. Click the **Console log**, then type in the Console to query the Daytime server.

Perform a (GET) HTTP request

You can use the XBee to perform a GET Hypertext Transfer Protocol (HTTP) request using XBee Studio. HTTP is an application-layer protocol that runs over TCP. This example uses httpbin.org/ as the target website that responds to the HTTP request.

Note For help with debugging, see [Debugging](#).

To perform a GET request:

1. Ensure that the device is set up correctly with the SIM card installed and the antennas connected as described in [Connect the hardware](#).
2. Open XBee Studio and [Add a device](#) (this should happen automatically).
3. Navigate to the device settings page by one of the following methods:
 - Hover over your device and then click **Open Settings**.
 - Click on your device and then click **Settings** in the left menu.
 - Click **Configuration** in the sidebar, then click **Settings**, then finally click on your device.
4. To enter the destination address of the target website, in the **DL** field, type **httpbin.org** and click the **Write** button .
5. To enter the HTTP request port number, in the **DE** field, type **50** and click the **Write** button. Hexadecimal **50** is 80 in decimal.
6. To switch to TCP communication, in the **IP** field, select **1** and click the **Write** button.
7. To move into Transparent mode, in the **AP** field, select **0** and click the **Write** button.
8. Wait for the **AI** (Association Indication) value to change to **0** (Connected to the Internet).
9. Click the **Consoles working mode** button  on the toolbar.

10. From the AT console, click the **Add new packet button**  in the Send packets dialog. The **Add new packet** dialog appears.
11. Enter the name of the data packet.
12. Type the following data in the **ASCII** input tab:

```
GET /ip HTTP/1.1
Host: httpbin.org
```

13. Copy and paste the following text into the **HEX** input tab:
47 45 54 20 2F 69 70 20 48 54 54 50 2F 31 2E 31 0D 0A 48 6F 73 74 3A 20 68 74 74
70 62 69 6E 2E 6F 72 67 0D 0A 0D 0A

Note The HTTP protocol requires an empty line (a line with nothing preceding the CRLF) to terminate the request.

14. Click **Add packet**.
15. Click the **Open** button .
16. Click **Send selected packet**.
17. A GET HTTP response from httpbin.org appears in the Console log.

Connect to a TCP/IP address

The XBee Cellular Modem can send and receive TCP messages while in Transparent mode; see [Transparent operating mode](#).

Note You can use this example as a template for sending and receiving data to or from any TCP/IP server.

Note For help with debugging, see [Debugging](#).

The following table explains the AT commands that you use in this example.

Command	Value	Description
IP (IP Protocol)	1	Set the expected transmission mode to TCP communication.
DL (Destination IP Address)	<Target IP address>	The target IP address that you send and receive from. For example, a data logging server's IP address that you want to send measurements to.
DE (Destination Port)	<Target port number>	The target port number that the device sends the transmission to. This is represented as a hexadecimal value.

To connect to a TCP/IP address:

1. Ensure that the device is set up correctly with the SIM card installed and the antennas connected as described in [Connect the hardware](#).

2. Open Xbee Studio and [Add a device](#) (this should happen automatically).
3. Navigate to the device settings page by one of the following methods:
 - Hover over your device and then click **Open Settings**.
 - Click on your device and then click **Settings** in the left menu.
 - Click **Configuration** in the sidebar, then click **Settings**, then finally click on your device.
4. In the **IP** field, select 1 and click the **Write** button .
5. In the **DL** field, type the <target IP address> and click the **Write** button. The target IP address is the IP address that you send and receive from.
6. In the **DE** field, type the <target port number>, converted to hexadecimal, and click the **Write** button.
7. [Exit Command mode](#).

After exiting Command mode, any serial data sent to the device is sent to the destination IP address and port number after the [RO \(Packetization Timeout\)](#) occurs.

Debugging

If you experience problems with the settings in the examples, you can load the default settings in Xbee Studio.

Note If you load the default settings, you will need to reapply any configuration settings that you have previously made.

1. On the Configuration toolbar, click the **Default** button  to load the default values established by the firmware, and click **Yes** to confirm.
2. Factory settings are loaded but not written to the device. To write them, click the **Write** button  on the toolbar.

Software libraries

One way to communicate with the Xbee device is by using a software library. The libraries available for use with the Xbee Cellular Modem include:

- [Xbee Java library](#)
- [Xbee Python library](#)
- [Xbee ANSI C library](#)

The Xbee Java Library is a Java API. The package includes the Xbee library, its source code and a collection of samples that help you develop Java applications to communicate with your Xbee devices.

The Xbee Python Library is a Python API that dramatically reduces the time to market of Xbee projects developed in Python and facilitates the development of these types of applications, making it an easy process.

Get started with Digi Remote Manager

Digi Remote Manager® is a cloud-based device and data management platform that you can use to configure and update a device, and view and manage device data.

The sections below describe how to create a Remote Manager account, upgrading your device, configure your device, and manage data in Remote Manager.

1. [Create a Remote Manager account and add devices](#)
2. To ensure that all Remote Manager features are available, you should upgrade your device to the latest firmware. See [Update the firmware from the Devices page in Remote Manager](#) or [Update the firmware using web services in Remote Manager](#).
3. **Configure your device in Remote Manager**
To be able to configure your device in Remote Manager, the device must be connected to Remote Manager. You can connect to and configure your device in Remote Manager using one of the following methods:
 - **Scheduled connection:** In this method, you create a list of tasks that you want to perform on the device, and then start the operation. This is the recommended method, and is the best choice for low data usage. See [Configure Remote Manager features using automations](#).
 - **Always connected:** This method can be used for initial configuration, or when you are not concerned with low data usage. See [Configure XBee settings within Remote Manager](#).
4. [Secure the connection between an XBee and Remote Manager with server authentication](#).
5. [Manage data in Remote Manager](#)
6. [Remote Manager reference](#)

Create a Remote Manager account and add devices

To be able to use Remote Manager, you must create a Remote Manager account and add your XBee devices to the device list. You should also verify that the device is enabled to connect to Remote Manager.

1. [Create a Remote Manager account](#).
2. [Add an XBee Cellular Modem to Remote Manager](#).
3. [Verify the connection between a device and Remote Manager](#)

Create a Remote Manager account

Digi Remote Manager is an on-demand service with no infrastructure requirements. Remote devices and enterprise business applications connect to Remote Manager through standards-based web services. This section describes how to configure and manage an XBee using Remote Manager. For detailed information on using Remote Manager, refer to the [Remote Manager User Guide](#), available via the **Documentation** tab in Remote Manager.

Before you can manage an XBee with Remote Manager, you must create a Remote Manager account. To create a Remote Manager account:

1. Go to <https://www.digi.com/products/iot-software-services/digi-remote-manager>.
2. Click **90 DAY FREE TRIAL/LOGIN**.
3. Follow the online instructions to complete account registration. You can upgrade your Developer account to a paid account at any time.

When you are ready to deploy multiple XBee Cellular Modems in the field, upgrade your account to access additional Remote Manager features.

Add an XBee Cellular Modem to Remote Manager

Each XBee Cellular Modem must be added to the Remote Manager account inventory list.

Before adding an XBee to your Remote Manager account inventory, you need to determine the International Mobile Equipment Identity (IMEI) number for the device. Use XBee Studio to view the IMEI number by querying the [IM parameter](#).

To add an XBee to your Remote Manager account inventory, follow these steps:

1. [Log into Remote Manager](#).
2. Click **Devices**.
3. Click **Add**.
4. In the **Device ID, MAC Address or IMEI** field, type or paste the IMEI number of the XBee you want to add.
5. For **Security Code**, enter in the security code on the printed label packaged with your device. The same security code is also shown on the label affixed to the bottom of the device.
6. Click **Add Device** to add the device. The XBee is added to your inventory.

Verify the connection between a device and Remote Manager

By default, the XBee is configured to enable communication with Remote Manager. The communication between XBee and Remote Manager is achieved using periodic UDP operations. You should verify the default settings to ensure that communication will work as desired.

1. [Launch XBee Studio](#) .
2. Verify that the [MO command](#) is set to **6**, which is the default.
3. Configure the frequency of polls for Remote Manager activity using the [DF command](#). The default is 1440 minutes (24 hours).
4. Enable the SM/UDP feature in Remote Manager for each device. See [Enable SM/UDP](#).

5. To ensure that the device is connected to Remote Manager, you must send an SM/UDP request.
 - a. [Log into Remote Manager](#).
 - b. Click **Devices** in the left pane.
 - c. Select the device that you want to work with.
 - d. From the right pane, click **Actions** and then **SM/UDP Request Connect**.
 - e. If you would like a response, enable **Request Response**.
 - f. Click **Request Connect**. When the connection is made, the **Connection Status** icon next to the device on the **Devices** page turns green.



Configure Remote Manager features using automations

Remote Manager provides tools to perform common management and maintenance tasks on your XBee device. Remote Manager automations are a sequence of commands that can be performed on one or more XBee Cellular devices. When an automation is run it becomes an active operation and can be monitored for status and completion.

Note You must upgrade your device to the latest firmware for all features to be available. See [Update the firmware](#).

Some typical examples of useful things that can be done with automations s include:

- [Change configuration](#)
- [Update your MicroPython application](#) and libraries to add features and capabilities
- Update your security certificates
- Perform a data service device request
- Send an SMS message to your device

Automations can be created and performed through the following methods:

- Remote Manager Automations user interface
- Remote Manager **API Explorer** user interface
- Programming web service calls

Note For any of these methods to work properly, you must have SM/UDP enabled. See [Enable SM/UDP](#).

Overview: Create an automation

When using the [most current firmware version](#), the XBee Cellular devices are designed to poll Remote Manager once per day over the SM/UDP protocol to check for any active operations. In order to perform a set of tasks, the device needs to be told to connect to Remote Manager, perform the sequence of tasks, and then told to disconnect.

The following provides a template of how to create a schedule for an XBee to connect, perform a set of tasks and then disconnect:

1. Make sure that SM/UDP is enabled. See [Enable SM/UDP](#).
2. [Log into Remote Manager](#).
3. Click **Automations**.
4. Click **Create** to launch the wizard.
5. In the **Details** section:
 - a. In the **Name** field, enter a descriptive name for the automation, such as "Connect devices".
 - b. Click **Save and Continue**.
6. In the **Steps** section:
 - a. Click the garbage icon to delete any existing steps.
 - b. Click **+** to add a step, and select **SM/UDP Request Connect**.
 - c. Add other steps as needed. For examples, refer to the [Automation examples](#) section.
 - d. Click **+** to add a step, and select **Disconnect**.
 - e. Click **Save and Continue**.
7. In the **Targets** section, click **Skip** to skip this section.
8. In the **Triggers** section, click **Skip** to skip this section.
9. Start the automation on a set of devices.
 - a. Click **Automations** to show the list of available automations.
 - b. Select the automation that you just created.
 - c. Click **Action > Run Automation**. The **Run Automations** window displays.
 - d. Click the **Devices** tab.
 - e. Select all of the devices you want to run the automation on.
 - f. Click **Confirm** to start the automation.

Automation examples

The examples in the following sections assume you are using the Digi Remote Manager Automations wizard. However, you should be aware that operations can be created and performed programmatically via web service calls or via the API explorer. The XML web service calls provide more options than are available in the GUI dashboard for some tasks.

Example: Read settings and state using Remote Manager

In order to configure devices you will need to know the structure of the XML for your XBee's settings. The easiest way to obtain this is to perform a `query_setting` RCI request against your device.

Note You must upgrade your device to the latest firmware for all features to be available. See [Update the firmware](#).

Note To obtain the state of the device, you can perform the same operations in the example below, but replace `query_setting` with `query_state`.

1. [Log into Remote Manager](#).
2. Click **Automations**.

3. Click **Create** to launch the wizard.
4. In the **Details** section:
 - a. In the **Name** field, enter a descriptive name for the automation, such as "Read Settings".
 - b. Click **Save and Continue**.
5. In the **Steps** section:
 - a. Click the garbage icon to delete any existing steps.
 - b. Click **+** to add a step, and select **SM/UDP Request Connect**.
 - c. Click **+** again to add another step, and select **RCI**.
 - i. In the **RCI Payload** field, enter:

```
<query_setting/>
```

 - ii. Enable **Allow Offline**.
 - d. Click **+** to add a step, and select **Disconnect**.
 - e. Click **Save and Continue**.
6. In the **Targets** section, click **Skip** to skip this section.
7. In the **Triggers** section, click **Skip** to skip this section.
8. Start the automation on a set of devices.
 - a. Click **Automations** to show the list of available automations.
 - b. Select the automation that you just created.
 - c. Click **Action > Run Automation**. The **Run Automations** window displays.
 - d. Click the **Devices** tab.
 - e. Select all of the devices you want to run the automation on.
 - f. Click **Confirm** to start the automation.
9. Verify the results of running the automation.
 - a. Click **Automations** to show the list of automations.
 - b. Click on the name of the automation you just ran to display the status window.
 - c. Click the **Runs** tab to see all of the runs for this automation.
 - d. Click on the run you are interested in to display a details for each device.
 - e. For the device you are interested in, click the **Status** link under the **Summary** column to see more details and the responses.

If the status was successful, you can see the response of the RCI query by clicking **Show Details**. This XML structure has the same settings that you will use in the `set_setting` command to configure your XBee as shown in this example: [Example: Configure a device from Remote Manager using XML](#).

Example: Configure a device from Remote Manager using XML

You can configure each XBee device from Remote Manager, using XML. The devices must be in the Remote Manager inventory device list and be active.

Note You must upgrade your device to the latest firmware for all features to be available. See [Update the firmware](#).

In this configuration example, you are changing the device to poll four times a day instead of just once. In this case, you should change the **DF** parameter to 360 minutes.

1. [Log into Remote Manager](#).
2. Click **Automations**.
3. Click **Create** to launch the wizard.
4. In the **Details** section:
 - a. In the **Name** field, enter a descriptive name for the automation, such as "Set Settings".
 - b. Click **Save and Continue**.
5. In the **Steps** section:
 - a. Click the garbage icon to delete any existing steps.
 - b. Click **+** to add a step, and select **SM/UDP Request Connect**.
 - c. Click **+** again to add another step, and select **RCI**.
 - i. In the **RCI Payload** field, enter:

```
<set_setting>
  <remote_manager>
    <DF>360</DF>
  </remote_manager>
</set_setting>
```

 - ii. Enable **Allow Offline**.
 - d. Click **+** to add a step, and select **Disconnect**.
 - e. Click **Save and Continue**.
6. In the **Targets** section, click **Skip** to skip this section.
7. In the **Triggers** section, click **Skip** to skip this section.
8. Start the automation on a set of devices.
 - a. Click **Automations** to show the list of available automations.
 - b. Select the automation that you just created.
 - c. Click **Action > Run Automation**. The **Run Automations** window displays.
 - d. Click the **Devices** tab.
 - e. Select all of the devices you want to run the automation on.
 - f. Click **Confirm** to start the automation.
9. Verify the results of running the automation.
 - a. Click **Automations** to show the list of automations.
 - b. Click on the name of the automation you just ran to display the status window.
 - c. Click the **Runs** tab to see all of the runs for this automation.
 - d. Click on the run you are interested in to display a details for each device.
 - e. For the device you are interested in, click the **Status** link under the **Summary** column to see more details and the responses.

Example: Schedule an automation to update the device firmware using Remote Manager

You can use an automation to update the XBee Cellular firmware. Since the device is configured by default to poll Remote Manager once a day, you need to be able to set up a scheduled task to update the device's firmware to take advantage of new features and fixes. To update the firmware to a new version you will need to obtain the .ebin file for the new firmware from our support site.

This file is one of the files in the .zip (for example, XBXC-31011.zip) archive that you can download for the product.

Note You must upgrade your device to the latest firmware for all features to be available. See [Update the firmware](#).

To upgrade using an automation, perform the following steps:

1. [Log into Remote Manager](#).
2. Make sure that you have enabled SM/UDP. See [Enable SM/UDP](#).
3. Click **Automations**.
4. Click **Create** to launch the wizard.
5. In the **Details** section:
 - a. In the **Name** field, enter a descriptive name for the automation, such as "Firmware update".
 - b. Click **Save and Continue**.
6. In the **Steps** section:
 - a. Click the garbage icon to delete any existing steps.
 - b. Click **+** to add a step, and select **SM/UDP Request Connect**.
 - c. Click **+** again to add another step, and select **Update Firmware**.
 - i. From the **Device Type** list box, select the device type.
 - ii. From the **Firmware Version** list box, select the version of the firmware to which you want to update the device.
 - d. Click **+** to add a step, and select **Disconnect**.
 - e. Click **Save and Continue**.
7. In the **Targets** section, click **Skip** to skip this section.
8. In the **Triggers** section, click **Skip** to skip this section.
9. Start the automation on a set of devices.
 - a. Click **Automations** to show the list of available automations.
 - b. Select the automation that you just created.
 - c. Click **Action > Run Automation**. The **Run Automations** window displays.
 - d. Click the **Devices** tab.
 - e. Select all of the devices you want to run the automation on.
 - f. Click **Confirm** to start the automation.
10. Verify the results of running the automation.
 - a. Click **Automations** to show the list of automations.
 - b. Click on the name of the automation you just ran to display the status window.
 - c. Click the **Runs** tab to see all of the runs for this automation.
 - d. Click on the run you are interested in to display a details for each device.
 - e. For the device you are interested in, click the **Status** link under the **Summary** column to see more details and the responses.

Example: Update MicroPython from Remote Manager using an automation

You can create an automation to update the MicroPython application. In this example, you want to add FTP client capability to the MicroPython application. You will need to add the library `uftp.py` and then update the `main.py` application.

1. [Log into Remote Manager](#).
2. Make sure that SM/UDP is enabled. See [Enable SM/UDP](#).
3. Click **Automations**.
4. Click **Create** to launch the wizard.
5. In the **Details** section:
 - a. In the **Name** field, enter a descriptive name for the automation, such as "Update application".
 - b. Click **Save and Continue**.
6. In the **Steps** section:
 - a. Click the garbage icon to delete any existing steps.
 - b. Click **+** to add a step, and select **SM/UDP Request Connect**.
 - c. Click **+** again to add another step, and select **RCI**.
 - i. In the **RCI Payload** field, enter:

```
<set_setting>
  <remote_manager>
    <MO>7</MO>
  </remote_manager>
</set_setting>
```

 - ii. Enable **Allow Offline**.
 - iii. From the **On Error** list box, select **Continue**.

This step disables the MicroPython application so the MicroPython files can be updated, and configures the device to keep the connection open to remote manager.
 - d. Click **+** again to add another step, and select **Reboot**.
 - i. Enable **Allow Offline**.
 - ii. From the **On Error** list box, select **Continue**.
 - e. Click **+** again to add another step, and select **Upload Files**.
 - i. From the **Choose File** list box, select **main.py** from the FTP sample application.
 - ii. In the **Destination File Path** field, enter: `~/MicroPython/main.py`
 - iii. Enable **Allow Offline**.
 - iv. From the **On Error** list box, select **Continue**.
 - f. Click **+** again to add another step, and select **Upload Files**.
 - i. From the **Choose File** list box, select the **uftp.py** file from the FTP sample application.
 - ii. In the **Destination File Path** field, enter: `~/MicroPython/uftp.py`

- iii. Enable **Allow Offline**.
 - iv. From the **On Error** list box, select **Continue**.
 - g. Click **+** again to add another step, and select **RCI**.
 - i. In the **RCI Payload** field, enter:

```

<set_setting>
  <micropython>
    <PS>1</PS>
  </micropython>
  <remote_manager>
    <MO>6</MO>
  </remote_manager>
</set_setting>
          
```

 - ii. Enable **Allow Offline**.
 - iii. From the **On Error** list box, select **Continue**.
 - h. Click **+** again to add another step, and select **Reboot**.
 - i. Enable **Allow Offline**.
 - ii. From the **On Error** list box, select **Continue**.
 - i. Click **+** to add a step, and select **Disconnect**.
 - j. Click **Save and Continue**.
7. In the **Targets** section, click **Skip** to skip this section.
 8. In the **Triggers** section, click **Skip** to skip this section.
 9. Start the automation on a set of devices.
 - a. Click **Automations** to show the list of available automations.
 - b. Select the automation that you just created.
 - c. Click **Action > Run Automation**. The **Run Automations** window displays.
 - d. Click the **Devices** tab.
 - e. Select all of the devices you want to run the automation on.
 - f. Click **Confirm** to start the automation.
 10. Verify the results of running the automation.
 - a. Click **Automations** to show the list of automations.
 - b. Click on the name of the automation you just ran to display the status window.
 - c. Click the **Runs** tab to see all of the runs for this automation.
 - d. Click on the run you are interested in to display a details for each device.
 - e. For the device you are interested in, click the **Status** link under the **Summary** column to see more details and the responses.

Manage data in Remote Manager

You can view and manage XBee data in Remote Manager.

Review device status information from Remote Manager

You can view address, Bluetooth® Low Energy (LE), cellular, firmware, and I/O sampling status information for a XBee device in Remote Manager. The device must be in the Remote Manager

inventory device list and be active.

1. Set up a persistent connection to connect the device to Remote Manager using one of the following methods:
 - **Remote Manager:** A persistent connection can be set up in Remote Manager. This option should be used when you have many deployed devices and no local access. See [Set up a persistent connection to a remote XBee](#).
 - **XBee Studio:** This option allows immediate access, and should be used when you have local access, such as when using a development kit or in a lab environment.
2. [Log into Remote Manager](#).
3. Click **Devices**.
4. Select the device that you want to configure.
5. Click **Settings** and expand **Config**.
6. Click on the setting group that has information you want to display. The setting information is related to AT commands. For information about each AT command in the categories, click on the appropriate link below.
 - [Addressing](#)
 - [Cellular](#)
 - [Firmware Version/Information](#)
 - [I/O](#)
7. When all changes are complete, [disconnect the device](#) from Remote Manager.

Manage secure files in Remote Manager

You can interact with files on the XBee device from Remote Manager, using either the [SCI \(Server command interface\)](#) or in the **File Management** view.

You can securely upload files by appending a hash sign (#) to the end of the file name. After the upload, the hash sign (#) is not retained as part of the file name. For example, you could upload a file named *my-cert.crt* appended with a hash sign (#): *my-cert.crt#*. After the upload is complete, the file is named *my-cert.crt*.

Note Uploading secure files in Remote Manager has the same result as doing an [ATFS XPUT](#) locally. See [Secure files](#) for more information.

SCI (Server command interface)

You can use the [SCI \(Server command interface\)](#) `file_system` command to securely upload a file. For more information, see the `file_system` section in the [Digi Remote Manager Programming Guide](#).

Device Files view

You can upload and manage files in the Remote Manager **Device Files** view.

1. [Log into Remote Manager](#).
2. Click **Devices**.
3. Select the device for which you want to manage files.

4. Click **Files** to open file management view. From this view you can add or remove files on your device.

Remote Manager reference

Enable SM/UDP

You can use the SM/UDP feature to leverage the very small data footprint of Remote Manager SM protocol over UDP.

Note Battery Operated Mode may be enabled in Digi Remote Manager. Review the [Battery Operated Mode section](#) to determine the impact of enabling this mode on SM/UDP.

1. [Log into Remote Manager](#).
2. Click **Devices**.
3. Select the device that you want to configure.
4. Click **Details**.
5. From the **Actions** list box, choose **Configure SM/UDP**.
6. Click **Enable**.

TCP connection

The TCP connection between an XBee and Remote Manager is dependent on the device's firmware version. Options are to query Remote Manager once a day or to maintain a persistent TCP connection.

To determine which connection method is being used, refer to the version listed below.

Module	Upgrade firmware version
XBee 3G	11311

- **At or above the listed version:** If your firmware version is at or above the listed version, your device queries Remote Manager only once a day. The device connects to Remote Manager, queries Remote Manager for updates and then receives updates. When the update is complete, the device disconnects from Remote Manager.

If you upgrade to the new firmware version, it is recommended that you keep the polling frequency low to reduce data usage. In order to upgrade firmware in the future, refer to [Example: Schedule an automation to update the device firmware using Remote Manager](#).

Note If you wish to restore the persistent connection behavior that was the default in prior firmware versions, see [Set up a persistent connection to a remote XBee](#).

- **Below the listed version:** If your firmware version is below the listed version, a persistent TCP connection is used by default. The device is continually connected to Remote Manager using TCP.

Set up a persistent connection to a remote XBee

The default connectivity to Remote Manager polls once a day using SM/UDP, which means that your XBee will always appear in a disconnected state and will use significantly less data.

If needed, you can set up a persistent connection, where the device is continually connected using TCP. To do this, you will need to set bit 0 of the [MO setting](#). The suggested value for **MO** is **7** to connect securely over TLS, or you can use **1** for no security, which is the legacy value.

You can make the change using one of the following methods:

- **Local access:** If you have local access to the device you can use XBee Studio to change the **MO** setting back to the former default value.
- **Remote access:** If you only have remote access to your XBee you can change the device to maintain a persistent connection to Remote Manager. To do this you can set up a scheduled operation in Remote Manager for your device, as shown below.

To set up an automation to enable a persistent connection:

1. [Log into Remote Manager](#).
2. Make sure that you have enabled SM/UDP. See [Enable SM/UDP](#).
3. Click **Automations**.
4. Click **Create** to launch the wizard.
5. In the **Details** section:
 - a. In the **Name** field, enter a descriptive name for the automation, such as "Enable persistent connection."
 - b. Click **Save and continue**.
6. In the **Steps** section:
 - a. Click the garbage icon to delete any existing steps.
 - b. Click **+** to add a step, and select **SM/UDP Request Connect**.
 - c. Click **+** again to add another step, and select **RCI**.
 - d. In the **RCI Payload** field, enter:

```
<set_setting>
  <remote_manager>
    <MO>7</MO>
  </remote_manager>
</set_setting>
```

 - e. Enable **Allow Offline**.
 - f. Click **Save and continue**.
7. In the **Targets** section, click **Skip** to skip this section.
8. In the **Triggers** section, click **Skip** to skip this section.

Disconnect

The TCP connection remains open and periodic polling occurs until you manually disconnect the TCP connection. After you have disconnected the TCP connection, Remote Manager is no longer updated.

You can disconnect the TCP connection using either of the following methods:

- From the **Devices** page in Remote Manager: See [Disconnect a device](#) in the *Digi Remote Manager® User Guide*.
- Using web services in Remote Manager: See [Request connect SM/UDP support](#) in the *Digi Remote Manager® Programming Guide*.

Determine the location of the firmware version

You must first determine the location of the firmware version to which you want to update. Digi provides updates by hosting them on an FTP server: **ftp1.digi.com**. If the FTP location is not accessible to your XBee Cellular, such as if you are using a VPN, the files may be retrieved and hosted separately on a server that it can reach.

Firmware is provided in the form of delta images which will migrate the cellular component from a known source to a given target version. You can verify the firmware version level of the cellular component using the **MV (Modem Version)** AT command. Check documentation and release notes for your XBee Cellular variant to determine the necessary upgrade path for your product.

You will need:

- The FTP hostname or IP address, which for Digi hosted files is: **ftp1.digi.com**
- The port running the FTP server, which is typically 21
- Username. For **ftp1.digi.com**, use: anonymous
- Password. For **ftp1.digi.com**, use your email address.
- Directory path containing update file.
- Update image filename.

Disconnect

The TCP connection remains open and periodic polling occurs until you manually disconnect the TCP connection. After you have disconnected the TCP connection, Remote Manager is no longer updated.

You can disconnect the TCP connection using either of the following methods:

- From the **Devices** page in Remote Manager: See [Disconnect a device](#) in the *Digi Remote Manager® User Guide*.
- Using web services in Remote Manager: See [Request connect SM/UDP support](#) in the *Digi Remote Manager® Programming Guide*.

Configure XBee settings within Remote Manager

You can configure the device settings to use features with Remote Manager. For more information, see [Example: Read settings and state using Remote Manager](#).

Configure device settings in Remote Manager

You can configure each XBee device from Remote Manager. The devices must be in the Remote Manager inventory device list and be active.

1. Set up a persistent connection to connect the device to Remote Manager using one of the following methods:
 - **Remote Manager:** A persistent connection can be set up in Remote Manager. This option should be used when you have many deployed devices and no local access.

See [Set up a persistent connection to a remote XBee](#).

- **XBee Studio:** This option allows immediate access, and should be used when you have local access, such as when using a development kit or in a lab environment. See [DO \(Device Options\)](#) and [MO \(Remote Manager Options\)](#). Both must be enabled.

2. [Log into Remote Manager](#).
3. Click **Devices**.
4. Select the device that you want to configure.
5. Click **Settings > Config**.
6. Click on the settings category that you want to configure. The settings in that category appear.
7. Make the desired configuration changes. See [AT commands](#) for information about each setting in the categories.
8. As you finish configuring in each setting category, click **Apply** to save the changes. If the changes are valid, Remote Manager writes them to non-volatile memory and applies them.
9. When all changes are complete, [disconnect the device](#) from Remote Manager.

Configure Remote Manager keepalive interval

Managing the data usage and the keepalive interval is important if you have the [MO \(Remote Manager Options\)](#) command bit 0 set to 1 or if you have enabled the [Request connect feature](#) in Remote Manager.

Digi Remote Manager is enabled on the XBee by default and has a 60 second keepalive interval, which can result in excessive cellular data usage, depending on your plan. The [K1](#) and [K2](#) commands can be used to tune the keepalive interval. Your carrier will disconnect an inactive socket automatically if there is no activity, so you need to tune this value based on your carrier's disconnect timeout.

You can further reduce your data usage by periodically duty cycling your Remote Manager connection, either from MicroPython or your host processor. For example, you could enable the Remote Manager connection for 2 hours a day and then disable the connection for 22 hours. Your host processor or MicroPython program would need to keep track of the time to ensure the time interval.

Configure SMS messaging in Remote Manager

You can configure a XBee device to use SMS functionality in Remote Manager. This feature uses a "request connect" operation and asks a device to make a full Transmission Control Protocol (TCP) connection to Remote Manager. For a device with SMS capability this can be significantly lower on latency and data cap consumption, as it does not involve polling.

Each device must be individually configured in Remote Manager to use this feature.

When the device receives an SMS message, it examines the message. If the phone number matches and content contains the correct service ID, it is processed internally rather than being delivered as user data.

By default, the device is configured with **32075** as the Remote Manager phone number and **idgp** as the Remote Manager service ID. If you need an alternate short (domestic) code or a long (international) code, you can re-configure the device using the [DP \(Remote Manager Phone Number\)](#) and [RI \(Remote Manager Service ID\)](#) commands.

Note The SMS provision feature cannot be used. This feature is found by selecting a device and then choosing **More > SMS > Provision**. Attempts to enable this feature are ignored.

1. Set up a persistent connection to connect the device to Remote Manager using one of the following methods:
 - **Remote Manager:** A persistent connection can be set up in Remote Manager. This option should be used when you have many deployed devices and no local access. See [Set up a persistent connection to a remote XBee](#).
 - **XBee Studio:** This option allows immediate access, and should be used when you have local access, such as when using a development kit or in a lab environment. See [DO \(Device Options\)](#) and [MO \(Remote Manager Options\)](#). Both must be enabled.
2. [Log in to Remote Manager](#).
3. Click **Devices**.
4. Select the device that you want to configure.
5. Click **Details**.
6. Click **Action > Configure SMS**.
7. In the **Phone Number** field, enter the device's SIM card phone number. You can use the [PH \(Phone Number\)](#) command to discover the device's phone number.
8. Expand the **More Options** section.
 - If you are using SMS in the United States only, make sure the **Server Phone** is **32075** and the **Server Keyword** is **idgp**. These are the default values allowed by the device.
 - If you are using SMS outside of the United States, enter the following:
 - **Server Phone:** 447537431797
 - **Server Keyword:** idgp .
 Because **Server Phone** is not the default used by the device, you must also update the [DP \(Remote Manager Phone Number\)](#) setting and [RI \(Remote Manager Service ID\)](#) setting on the device so that they match the **Server Phone** and **Server Keyword** settings.
9. Click **Save**.

Device Requests in Remote Manager

You can request to communicate with the XBee Cellular through Remote Manager by using the Data Services Device Request feature. The table below contains the data service target names that you can use to communicate with the XBee Cellular.

For more information on creating a data service device request as an automation step, see [Data Service Request](#) step in the [Digi Remote Manager User Guide](#).

Device request target name	Description
format	Use the format device request to format the XBee module's filesystem. For more information, see Format an XBee module .

Device request target name	Description
micropython	Use the micropython device request to communicate with a specified device using MicroPython. For more information, see Use the API Explorer to send Device Requests from the Digi MicroPython Programming Guide .

Format an XBee module

You can use the format device request target name to format the XBee module's filesystem. This process removes any previous contents and resets the module to a fresh state.

For best results, you should notify others that you plan to reformat the XBee's filesystem before you initiate a format device request.

When you initiate a format device request, the following occurs:

- The format operation closes all files open by other users of the system, including those that may be in use by a MicroPython application.
- The contents of the filesystem are reset to their initial default state.

Example:

```
<sci_request version="1.0">
  <data_service>
    <targets>
      <device id="Your Device ID here" />
    </targets>
    <requests>
      <device_request target_name="format"/>
    </requests>
  </data_service>
</sci_request>
```

Get started with MicroPython

This section provides an overview and simple examples of how to use MicroPython with the XBee Cellular Modem. You can use MicroPython to enhance the intelligence of the XBee to enable you to do edge-computing by adding logic in MicroPython, rather than using external components.

Note For in-depth information and more complex code examples, refer to the [Digi MicroPython Programming Guide](#).

Note For more information on using AWS and Azure, see the [xbec-micropython GitHub repo](#).

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About MicroPython

MicroPython is an open-source programming language based on Python 3, with much of the same syntax and functionality, but modified to fit on small devices with limited hardware resources, such as microcontrollers, or in this case, a cellular modem.

Why use MicroPython

MicroPython enables on-board intelligence for simple sensor or actuator applications using digital and analog I/O. MicroPython can help manage battery life. Cryptic readings can be transformed into useful data, excess transmissions can be intelligently filtered out, modern sensors and actuators can be employed directly, and logic can glue inputs and outputs together in an intelligent way.

For more information about MicroPython, see www.micropython.org.

For more information about Python, see www.python.org.

MicroPython on the XBee Cellular Modem

The XBee Cellular Modem has MicroPython running on the device itself. You can access a MicroPython prompt from the XBee Cellular Modem when you install it in an appropriate development board (XBDB or XBIB), and connect it to a computer via a USB cable.

Note MicroPython does not work with SPI.

The examples in this guide assume:

- You have [XBee Studio](#) on your computer. See [Install and upgrade XBee Studio](#).
- You have a terminal program installed on your computer. We recommend using the [Use the MicroPython terminal in XBee Studio](#).
- You have an XBee Cellular Modem installed in an appropriate development board, such as an XBIB-U-DEV.

Note Most examples in this guide require the XBIB-U-DEV board.

- The XBee Cellular Modem is connected to the computer via a USB cable and XBee Studio recognizes it.
- The board is powered by an appropriate power supply: 12 VDC.

Use XBee Studio to enter the MicroPython environment

To use the XBee Cellular Modem in the MicroPython environment:

1. Use XBee Studio to add the device(s); this should happen automatically. The terminal starts in a disconnected state by default.
2. Click **Open** to establish communication with the device corresponding to the terminal.
 - a. If the device is not in MicroPython REPL mode, a dialog will pop up, prompting you to enable it before connecting.
3. After the connection is established, the button icon changes to the connected state and the serial port status line and the terminal log controls are enabled.

At this point, all MicroPython logs of the application running in the device are captured and displayed in the terminal log control. If the device is not running any MicroPython application, nothing should be printed in the terminal log.

Work with MicroPython REPL

- If the device is not running a MicroPython app: press **Enter** on the terminal log. The MicroPython REPL prompt should appear for you to start working with it.
- Stop running the MicroPython app: press **Ctrl + C**. The MicroPython REPL prompt should appear for you to start working with it.

For more information, see the [XBee Studio User Guide](#).

Use the MicroPython Terminal in XBee Studio

You can use the MicroPython Terminal to communicate with the XBee Cellular Modem when it is in MicroPython mode.¹ This requires XCTU 6.3.7 or higher. To enter MicroPython mode, follow the steps in [Use XBee Studio to enter the MicroPython environment](#). To use the MicroPython Terminal:

1. Click **Open**. If you have not already added devices to XCTU:
 - a. In the **Select the Serial/USB port** area, click the COM port that the device uses.
 - b. Verify that the baud rate and other settings are correct.
2. Click the **Tools** drop-down menu  and select **MicroPython Terminal**. The terminal opens.
3. Click **OK**. The **Open** icon changes to **Close** , indicating that the device is properly connected.
4. Press **Ctrl+B** to get the MicroPython version banner and prompt.

You can now type or paste MicroPython commands at the **>>>** prompt.

Troubleshooting

If you receive **No such port: 'Port is already in use by other applications.'** in the **MicroPython Terminal** close any other console sessions open inside XCTU and close any other serial terminal programs connected to the device, then retry the MicroPython connection in XCTU.

If the device seems unresponsive, try pressing **Ctrl+C** to end any running programs.

You can use the **+++** escape sequence and look for an **OK** for confirmation that you have the correct baud rate.

Example: hello world

Before you begin, you must have previously added a device in XBee Studio. See [Add a device](#).

1. At the MicroPython **>>>** prompt, type the Python command: **print("Hello, World!")**
2. Press **Enter** to execute the command. The terminal echos back **Hello, World!**.

¹See [Other terminal programs](#) if you do not use the MicroPython Terminal in XCTU.

Example: Turn on an LED



1. Note the **DIO10** LED on the XBIB board. The following image highlights it in a red box. The LED is normally off.
2. At the MicroPython `>>>` prompt, type the commands below, pressing **Enter** after each one. After entering the last line of code, the LED illuminates. Anything after a `#` symbol is a comment, and you do not need to type it.

Note You can easily copy and paste code from the [online version of this guide](#). Use caution with the PDF version, as it may not maintain essential indentations.

```
from machine import Pin
led = Pin("D10", Pin.OUT, value=1) # Makes a pin object set to output 1.
```

3. To turn it off, type the following and press **Enter**:

```
led.value(0)
```

You have successfully controlled an LED on the board using basic I/O.

Example: Debug the secondary UART

This sample code is handy for debugging the secondary Universal Asynchronous Receiver/Transmitter (UART). It simply relays data between the primary and secondary UARTs.

```
from machine import UART
import sys, time

def uart_init():
    u = UART(1)
    u.write('Testing from XBee\n')
    return u

def uart_relay(u):
```

```

while True:
    uart_data = u.read(-1)
    if uart_data:
        sys.stdout.buffer.write(uart_data)
    stdin_data = sys.stdin.buffer.read(-1)
    if stdin_data:
        u.write(stdin_data)

    time.sleep_ms(5)

u = uart_init()
uart_relay(u)

```

You only need to call **uart_init()** once.

Call **uart_relay()** to pass data between the UARTs.

Send **Ctrl-C** to exit relay mode.

When done, call **u.close()** to close the secondary UART.

Exit MicroPython mode

To exit MicroPython mode:

1. In the XBee Studio MicroPython Terminal, click the green **Close** button .
2. Click **Close** at the top of the terminal to exit the terminal.
3. Navigate to the device settings page by one of the following methods:
 - Hover over your device and click **Open Settings**.
 - Click on your device and then click **Settings** in the left menu.
 - Click **Configuration** in the sidebar, then click **Settings**, then finally click on your device.
4. Change the **AP - API Enable** setting and then click the **Write** button. Since most examples use Transparent mode [0], it's recommended to change your device to that mode.

Other terminal programs

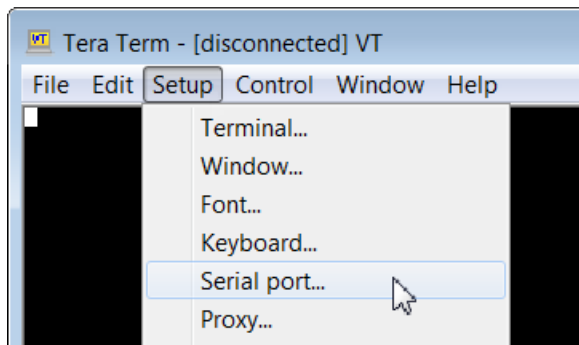
If you do not use the MicroPython Terminal in XBee Studio, you can use other terminal programs to communicate with the XBee Cellular Modem. If you use Microsoft Windows, follow the instructions for Tera Term; if you use Linux, follow the instructions for picocom. To download these programs:

- Tera Term for Windows. See <https://ttssh2.osdn.jp/index.html.en>.
- Picocom for Linux. See https://developer.ridgerun.com/wiki/index.php/Setting_up_Picocom_-_Ubuntu and for the source code and in-depth information <https://github.com/npatt-efault/picocom>.

Tera Term for Windows

With the XBee Cellular Modem in MicroPython mode (**AP = 4**), you can access the MicroPython prompt using a terminal.

1. Open Tera Term. The **Tera Term: New connection** window appears.
2. Click the **Serial** radio button to select a serial connection.
3. From the **Port:** drop-down menu, select the COM port that the XBee Cellular Modem is connected to.
4. Click **OK**. The **COMxx - Tera Term VT** terminal window appears and Tera Term attempts to connect to the device at a baud rate of 9600 b/s.
5. Click **Setup** and **Serial Port**. The **Tera Term: Serial port setup** window appears.



6. In the **Tera Term: Serial port setup** window, set the parameters to the following values:
 - **Port:** Shows the port that the XBee Cellular Modem is connected on.
 - **Baud rate:** 9600
 - **Data:** 8 bit
 - **Parity:** none
 - **Stop:** 1 bit
 - **Flow control:** hardware
 - **Transmit delay:** N/A
7. Click **OK** to apply the changes to the serial port settings. The settings should go into effect right away.
8. To verify that local echo is not enabled and that extra line-feeds are not enabled:
 - a. In Tera Term, click **Setup** and select **Terminal**.
 - b. In the **New-line** area of the **Tera Term: Serial port setup** window, click the **Receive** drop-down menu and select **CR** if it does not already show that value.
 - c. Make sure the **Local echo** box is not checked.
9. Click **OK**.
10. Press **Ctrl+B** to get the MicroPython version banner and prompt.

```
MicroPython v1.8.7 on 2017-04-06; XBee Cellular with EFM32G
Type "help()" for more information.
>>>
```

Now you can type MicroPython commands at the >>> prompt.

Use picocom in Linux

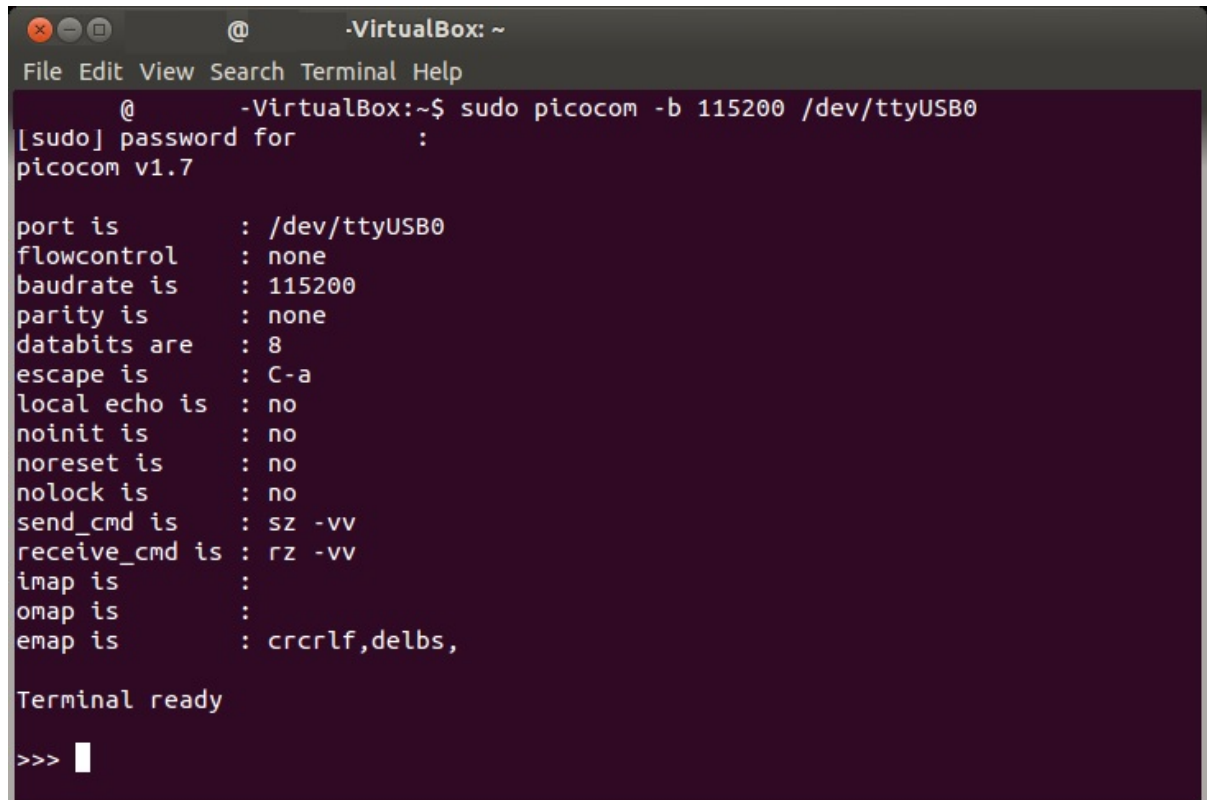
With the XBee Cellular Modem in MicroPython mode (**AP = 4**), you can access the MicroPython prompt using a terminal.

Note The user must have read and write permission for the serial port the XBee Cellular Modem is connected to in order to communicate with the device.

1. Open a terminal in Linux and type **picocom -b 9600 /dev/ttyUSB0**. This assumes you have no other USB-to-serial devices attached to the system.
2. Press **Ctrl+B** to get the MicroPython version banner and prompt. You can also press **Enter** to bring up the prompt.

If you do have other USB-to-serial devices attached:

1. Before attaching the XBee Cellular Modem, check the directory **/dev/** for any devices named **ttUSBx**, where **x** is a number. An easy way to list these is to type: **ls /dev/ttyUSB***. This produces a list of any device with a name that starts with **ttUSB**.
2. Take note of the devices present with that name, and then connect the XBee Cellular Modem.
3. Check the directory again and you should see one additional device, which is the XBee Cellular Modem.
4. In this case, replace **/dev/ttyUSB0** at the top with **/dev/ttyUSB<number>**, where **<number>** is the new number that appeared.
5. It should connect and show Terminal ready.



```
@ -VirtualBox: ~
File Edit View Search Terminal Help

@ -VirtualBox:~$ sudo picocom -b 115200 /dev/ttyUSB0
[sudo] password for :
picocom v1.7

port is       : /dev/ttyUSB0
flowcontrol   : none
baudrate is   : 115200
parity is     : none
databits are  : 8
escape is     : C-a
local echo is : no
noinit is     : no
noreset is    : no
nolock is     : no
send_cmd is   : SZ -vv
receive_cmd is : rZ -vv
imap is       :
omap is       :
emap is       : crcrlf,delbs,

Terminal ready

>>> |
```

Now you can type MicroPython commands at the >>> prompt.

Examples: IOT protocols with transparent mode

The following examples provide some additional scenarios you can use to get familiar with the XBee.

If you are interested in using the intelligence built into the XBee, see [Get started with MicroPython](#).

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Get started with CoAP

Constrained Application Protocol (CoAP) is based on UDP connection and consumes low power to deliver similar functionality to HTTP. This guide contains information about sending GET, POST, PUT and DELETE operations by using the Coap Protocol with XBee Studio and Python code working with the XBee Cellular Modem and Coaphon library (Python 2.7 only).

The Internet Engineering Task Force describes CoAP as:

The protocol is designed for machine-to-machine (M2M) applications such as smart energy and building automation. CoAP provides a request/response interaction model between application endpoints, supports built-in discovery of services and resources, and includes key concepts of the Web such as URIs and Internet media types. CoAP is designed to easily interface with HTTP for integration with the Web while meeting specialized requirements such as multicast support, very low overhead, and simplicity for constrained environments ([source](#)).

CoAP terms

When describing CoAP, we use the following terms:

Term	Meaning
Method	COAP's method action is similar to the HTTP method. This guide discusses the GET, POST, PUT and DELETE methods. With these methods, the XBee Cellular Modem can transport data and requests.
URI	URI is a string of characters that identifies a resource served at the server.
Token	A token is an identifier of a message. The client uses the token to verify if the received message is the correct response to its query.
Payload	The message payload is associated with the POST and PUT methods. It specifies the data to be posted or put to the URI resource.
Message ID	The message ID is also an identifier of a message. The client matches the message ID between the response and query.

CoAP quick start example

The following diagram shows the message format for the CoAP protocol; see [ISSN: 2070-1721](#) for details:

0	1	2	3
0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1
Ver	T	TKL	Code
Token (if any, TKL bytes) ...			
Options (if any) ...			
1 1 1 1 1 1 1 1	Payload (if any) ...		

This is an example GET request:

44 01 C4 09 74 65 73 74 B7 65 78 61 6D 70 6C 65

The following table describes the fields in the GET request.

Field	HEX	Bits	Meaning
Ver	44	01	Version 01, which is mandatory here.
T		00	Type 0: confirmable.
TKL		0100	Token length: 4.
Code	01	000 00001	Code: 0.01, which indicates the GET method.
Message ID	C4 09	2 Bytes equal to hex at left	Message ID. The response message will have the same ID. This can help out identification.
Token	74 65 73 74	4 Bytes equal to hex at left	Token. The response message will have the same token. This can help out identification.
Option delta	B7	1011	Delta option: 11 indicates the option data is Uri-Path.
Option length		0111	Delta length: 7 indicates there are 7 bytes of data following as a part of this delta option.
Option value	65 78 61 6D 70 6C 65	7 Bytes equal to hex at left	Example.

Configure the device

1. Ensure that the device is set up correctly with the SIM card installed and the antennas connected as described in [Connect the hardware](#).
2. Open XBee Studio and [Add a device](#) (this should happen automatically).
3. Navigate to the device settings page by one of the following methods:
 - Hover over your device and then click **Open Settings**.
 - Click on your device and then click **Settings** in the left menu.
 - Click **Configuration** in the sidebar, then click **Settings**, then finally click on your device.
4. To switch to UDP communication, in the **IP** field, select **0** and click the **Write** button .
5. To set the target IP address that the XBee Cellular Modem will talk to, in the **DL** field type **52.43.121.77** and click the **Write** button . A CoAP server is publicly available at address 52.43.121.77.
6. To set the XBee Cellular Modem to send data to port 5683 in decimal, in the **DE** field, type **1633** and click the **Write** button.
7. To move into Transparent mode, in the **AP** field, select **0** and click the **Write** button.
8. Wait for the **AI** (Association Indication) value to change to **0** (Connected to the Internet). You can click **Read**  to get an update on the **AI** value.

Example: manually perform a CoAP request

Follow the steps in [Configure the device](#) prior to this example. This example performs the CoAP GET request:

- Method: GET
 - URI: example
 - Given message token: test
1. Click the **Consoles working mode** button  on the toolbar to add a customized packet.
 2. From the AT console, click the **Add new packet button**  in the Send packets dialog. The **Add new packet** dialog appears.
 3. Click the **HEX** tab and type the name of the data packet: **GET_EXAMPLE**.
 4. Copy and past the following text into the **HEX** input tab:
44 01 C4 09 74 65 73 74 B7 65 78 61 6D 70 6C 65
This is the CoAP protocol message decomposed by bytes to perform a GET request on an example URI with a token test.
 5. Click **Add packet**.
 6. Click the **Open** button .
 7. Click **Send selected packet**. The message is sent to the public CoAP server configured in [Configure the device](#). A response appears in the Console log. Blue text is the query, red text is the response.

The payload is **Get to uri: example**, which specifies that this is a successful CoAP GET to URI end example, which was specified in the query.

Click the **Close** button to terminate the serial connection.

Example: Use Python to generate a CoAP message

This example illustrates how the CoAP protocol can perform GET/POST/PUT/DELETE requests similarly to the HTTP protocol and how to do this using the XBee Cellular Modem. In this example, the XBee Cellular Modem talks to a CoAP Digi Server. You can use this client code to provide an abstract wrapper to generate a CoAP message that commands the XBee Cellular Modem to talk to the remote CoAP server.

Note It is crucial to configure the XBee Cellular Modem settings. See [Configure the device](#) and follow the steps. You can target the IP address to a different CoAP public server.

1. Install Python 2.7. The Installation guide is located at: python.org/downloads/.
2. Download and install the CoAPthon library in the python environment from pypi.python.org/pypi/CoAPthon.
3. Download these two .txt files: [Coap.txt](#) and [CoapParser.txt](#). After you download them, open the files in a text editor and save them as .py files.
4. In the folder that you place the Coap.py and CoapParser.py files, press **Shift + right-click** and then click **Open command window**.
5. At the command prompt, type **python Coap.py** and press **Enter** to run the program.

6. Type the USB port number that the XBee Cellular Modem is connected to and press **Enter**. Only the port number is required, so if the port is COM19, type 19.

Note If you do not know the port number, open XBee Studio and look at the XBee Cellular Modem in the **Radio Modules** list. This view provides the port number and baud rate, as in the figure below where the baud rate is 9600 b/s.

7. Type the baud rate and press **Enter**. You must match the device's current baud rate. XBee Studio provides the current baud rate in the **BD Baud Rate** field. In this example you would type **9600**.
8. Press **Y** if you want an auto-generated example. Press **Enter** to build your own CoAP request.
9. If you press **Y** it generates a message with:
 - Method: POST
 - URI: example
 - payload: hello world
 - token: test

The send and receive message must match the same token and message id. Otherwise, the client re-attempts the connection by sending out the request.

In the following figure, the payload contains the server response to the query. It shows the results for when you press **Enter** rather than **Y**.

```
C:\Users\jzhang\Desktop\example>python Coap.py
Please enter the serial port number for Xbee: 18
Please enter the baudrate number of Xbee: <9600 or 115200>: 9600
Do you want an auto-generated example <Press Y> or build your own <Press ENTER>:

Please enter the HTTP method <GET, POST, PUT, DELETE>: PUT
Please enter the uri end path: example
Please enter the payload content. And it cannot be empty: hello world
Please enter the token: digi

#####

This is the send out message:
Source: <None, None>
Destination: None
Type: CON
MID: 56045
Code: PUT
Token: digi
Uri-Path: example
Payload:
hello world

This is the received message
Source: <None, None>
Destination: None
Type: ACK
MID: 56045
Code: CHANGED
Token: digi
Payload:
Put hello world to uri: example
```

Get started with MQTT

MQ Telemetry Transport (MQTT) is a messaging protocol that is ideal for the Internet of Things (IoT) due to a light footprint and its use of the publish-subscribe model. In this model, a client connects to a broker, a server machine responsible for receiving all messages, filtering them, and then sending messages to the appropriate clients.

The first two MQTT examples do not involve the XBee Cellular Modem. They demonstrate using the MQTT libraries because those libraries are required for [Use MQTT over the XBee Cellular Modem with a PC](#).

The examples in this guide assume:

- Some knowledge of Python.
- An integrated development environment (IDE) such as PyCharm, IDLE or something similar.

The examples require:

- An XBee Cellular Modem.
- A compatible development board.
- XBee Studio. See [Install and upgrade XBee Studio](#).
- That you install Python on your computer. You can download Python from: <https://www.python.org/downloads/>.
- That you install the **pyserial** and **paho-mqtt** libraries to the Python environment. If you use Python 2, install these libraries from the command line with **pip install pyserial** and **pip install paho-mqtt**. If you use Python 3, use **pip3 install pyserial** and **pip3 install paho-mqtt**.
- The full MQTT library source code, which includes examples and tests, which is available in the paho-mqtt github repository at <https://github.com/eclipse/paho.mqtt.python>. To download this repository you must have Git installed.

Example: MQTT connect

This example provides insight into the structure of packets in MQTT as well as the interaction between the client and broker. MQTT uses different packets to accomplish tasks such as connecting, subscribing, and publishing. You can use XBee Studio to perform a basic example of sending a broker a connect packet and receiving the response from the server, without requiring any coding. This is a good way to see how the client interacts with the broker and what a packet looks like. The following table is an example connect packet:

	Description	Hex value
CONNECT packet fixed header		
byte 1	Control packet type	0x10
byte 2	Remaining length	0x10
CONNECT packet variable header		
Protocol name		
byte 1	Length MSB (0)	0x00
byte 2	Length LSB (4)	0x04
byte 3	(M)	0x4D
byte 4	(Q)	0x51

	Description	Hex value
byte 5	(T)	0x54
byte 6	(T)	0x54
Protocol level		
byte 7	Level (4)	0x04
Connect flags		
byte 8	CONNECT flags byte, see the table below for the bits.	0x02
Keep alive		
byte 9	Keep Alive MSB (0)	0x00
byte 10	Keep Alive LSB (60)	0x3C
Client ID		
byte 11	Length MSB (0)	0x00
byte 12	Length LSB (4)	0x04
byte 13	(D)	0x44
byte 14	(I)	0x49
byte 15	(G)	0x47
byte 16	(I)	0x49

The following table describes the fields in the packet:

Field name	Description
Protocol Name	The connect packet starts with the protocol name, which is MQTT. The length of the protocol name (in bytes) is immediately before the name itself.
Protocol Level	Refers to the version of MQTT in use, in this case a value of 4 indicates MQTT version 3.1.1.
Connect Flags	Indicate certain aspects of the packet. For simplicity, this example only sets the Clean Session flag, which indicates to the client and broker to discard any previous session and start a new one.
Keep Alive	How often the client pings the broker to keep the connection alive; in this example it is set to 60 seconds.
Client ID	The length of the ID (in bytes) precedes the ID itself. Each client connecting to a broker must have a unique client ID. In the example, the ID is DIGI. When using the Paho MQTT Python libraries, a random alphanumeric ID is generated if you do not specify an ID.

The following table provides the CONNECT flag bits from byte 8, the CONNECT flags byte.

CONNECT Flag Bit(s)	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
User name flag	0							
Password flag		0						
Will retain			0					
Will QoS				0	0			
Will flag						0		
Clean session							1	
Reserved								0

Send a connect packet

Now that you know what a connect packet looks like, you can send a connect packet to a broker and view the response in XBee Studio.

1. Ensure that the device is set up correctly with the SIM card installed and the antennas connected as described in [Connect the hardware](#).
2. Open XBee Studio and [Add a device](#) (this should happen automatically).
3. Navigate to the device settings page by one of the following methods:
 - Hover over your device and then click **Open Settings**.
 - Click on your device and then click **Settings** in the left menu.
 - Click **Configuration** in the sidebar, then click **Settings**, then finally click on your device.
4. In the **AP** field, set **Transparent Mode** to **[0]** if it is not already and click the **Write** button.
5. In the **DL** field, type the IP address or the fully qualified domain name of the broker you wish to use. This example uses test.mosquitto.org.
6. In the **DE** field, type **75B** and set the port that the broker uses. This example uses **75B**, because the default MQTT port is 1883 (0x75B).
7. Navigate to the **XBee Console** by one of the following methods:
 - Hover over your device and then click **Open Device Console**.
 - Click on your device and then click **XBee Console** in the left menu.
 - Click **Development** in the sidebar, then click **XBee Console**, then finally click on your device.

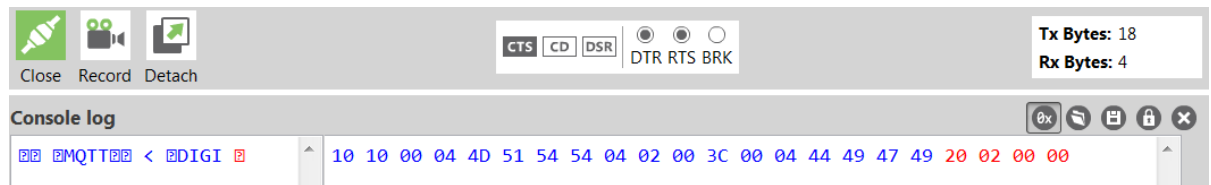
Note For instructions on using the Console, see the [XBee console](#) topic in the *XBee Studio User Guide*.

8. Click the **Open** button  to open a serial connection to the device.
9. From the AT console, click the **Add new packet button**  in the **Send packets** dialog. The **Add new packet** dialog appears.
10. Enter the name of the data packet. Name the packet **connect_frame** or something similar.

11. Click the **HEX** input tab and type the following (these values are the same values from the table in [Example: MQTT connect](#)):

10 10 00 04 4D 51 54 54 04 02 00 3C 00 04 44 49 47 49

12. Click **Add packet**. The new packet appears in the **Send packets** list.
13. Click the packet in the **Send packets** list.
14. Click **Send selected packet**.
15. A CONNACK packet response from the broker appears in the **Console log**. This is a connection acknowledgment; a successful response should look like this:



You can verify the response from the broker as a CONNACK by comparing it to the structure of a CONNACK packet in the MQTT documentation, which is available at http://docs.oasis-open.org/mqtt/mqtt/v3.1.1/os/mqtt-v3.1.1-os.html#_Toc398718081.

Example: send messages (publish) with MQTT

A basic Python example of a node publishing (sending) a message is:

```
mqttc = mqtt.Client("digitest") # Create instance of client with client
ID "digitest"
mqttc.connect("m2m.eclipse.org", 1883) # Connect to (broker, port,
keepalive-time)
mqttc.loop_start() # Start networking daemon
```

```

mqttc.publish("digitest/test1", "Hello, World!") # Publish message to
"digitest /test1" topic
mqttc.loop_stop() # Kill networking daemon

```

Note You can easily copy and paste code from the [online version of this guide](#). Use caution with the PDF version, as it may not maintain essential indentations.

This example imports the MQTT library, allowing you to use the MQTT protocol via APIs in the library, such as the **connect()**, **subscribe()**, and **publish()** methods.

The second line creates an instance of the client, named **mqttc**. The client ID is the argument you passed in: **digitest** (this is optional).

In line 3, the client connects to a public broker, in this case **m2m.eclipse.org**, on port **1883** (the default MQTT port, or 8883 for MQTT over TLS). There are many publicly available brokers available, you can find a list of them here: <https://github.com/mqtt/mqtt.github.io/wiki/brokers>.

Line 4 starts the networking daemon with **client.loop_start()** to handle the background network/data tasks.

Finally, the client publishes its message **Hello, World!** to the broker under the topic **digitest/backlog/test1**. Any nodes (devices, phones, computers, even microcontrollers) subscribed to that same topic on the same broker receive the message.

Once no more messages need to be published, the last line stops the network daemon with **client.loop_stop()**.

Example: receive messages (subscribe) with MQTT

This example describes how a client would receive messages from within a specific topic on the broker:

```

import paho.mqtt.client as mqtt

def on_connect(client, userdata, flags, rc): # The callback for when
    the client connects to the broker print("Connected with result
    code {0}".format(str(rc)))
    # Print result of connection attempt client.subscribe
    ("digitest/test1")
    # Subscribe to the topic "digitest/test1", receive any messages
    published on it

def on_message(client, userdata, msg): # The callback for when a PUBLISH
    message is received from the server. print("Message received-> "
    + msg.topic + " " + str(msg.payload)) # Print a received msg

client = mqtt.Client("digi_mqtt_test") # Create instance of client with
client ID "digi_mqtt_test"
client.on_connect = on_connect # Define callback function for successful
connection
client.on_message = on_message # Define callback function for receipt of
a message
# client.connect("m2m.eclipse.org", 1883, 60) # Connect to (broker, port,
keepalive-time)
client.connect('127.0.0.1', 17300)

```

```
client.loop_forever() # Start networking daemon
```

Note You can easily copy and paste code from the [online version of this guide](#). Use caution with the PDF version, as it may not maintain essential indentations.

The first line imports the library functions for MQTT.

The functions **on_connect** and **on_message** are callback functions which are automatically called by the client upon connection to the broker and upon receiving a message, respectively.

The **on_connect** function prints the result of the connection attempt, and performs the subscription. It is wise to do this in the callback function as it guarantees the attempt to subscribe happens only after the client is connected to the broker.

The **on_message** function prints the received message when it comes in, as well as the topic it was published under.

In the body of the code, we:

- Instantiate a client object with the client ID **digi_mqtt_test**.
- Define the callback functions to use upon connection and upon message receipt.
- Connect to an MQTT broker at **m2m.eclipse.org**, on port **1883** (the default MQTT port, or 8883 for MQTT over TLS) with a keepalive of 60 seconds (this is how often the client pings the broker to keep the connection alive).

The last line starts a network daemon that runs in the background and handles data transactions and messages, as well as keeping the socket open, until the script ends.

Use MQTT over the XBee Cellular Modem with a PC

To use this MQTT library over an XBee Cellular Modem, you need a basic proxy that transfers a payload received via the MQTT client's socket to the serial or COM port that the XBee Cellular Modem is active on, as well as the reverse; transfer of a payload received on the XBee Cellular Modem's serial or COM port to the socket of the MQTT client. This is simplest with the XBee Cellular Modem in Transparent mode, as it does not require code to parse or create API frames, and not using API frames means there is no need for them to be queued for processing.

1. To put the XBee Cellular Modem in Transparent mode, set **AP** to **0**.
2. Set **DL** to the IP address of the broker you want to use.
3. Set **DE** to the port to use, the default is 1883 (0x75B). This sets the XBee Cellular Modem to communicate directly with the broker, and can be performed in XBee Studio as described in [Example: MQTT connect](#).
4. You can make the proxy with a dual-threaded Python script, a simple version follows:

```
import threading
import serial
import socket

def setup():
    """
    This function sets up the variables needed, including the serial port,
    and it's speed/port settings, listening socket, and localhost
    address.
```

```

"""
global clisock, cliaddr, svrsock, ser
# Change this to the COM port your XBee Cellular module is using. On
# Linux, this will be /dev/ttyUSB#
comport = 'COM44'
# This is the default serial communication speed of the XBee Cellular
# module
comspeed = 115200
buffer_size = 4096 # Default receive size in bytes
debug_on = 0 # Enables printing of debug messages
toval = None # Timeout value for serial port below
# Serial port object for XBCell modem
ser = serial.Serial(comport,comspeed,timeout=toval)
# Listening socket (accepts incoming connection)
svrsock = socket.socket(socket.AF_INET,socket.SOCK_STREAM)
# Allow address reuse on socket (eliminates some restart errors)
svrsock.setsockopt(socket.SOL_SOCKET, socket.SO_REUSEADDR, 1)
clisock = None
cliaddr = None # These are first defined before thread creation
addrtuple = ('127.0.0.1', 17300) # Address tuple for localhost
# Binds server socket to localhost (allows client program connection)
svrsock.bind(addrtuple)
svrsock.listen(1) # Allow (1) connection

def ComReaderThread():
    """
    This thread listens on the defined serial port object ('ser') for data
    from the modem, and upon receipt, sends it out to the client over the
    client socket ('clisock').
    """
    global clisock
    while (1):
        resp = ser.read() ## Read any available data from serial port
        print("Received {} bytes from modem.".format(len(resp)))

        clisock.sendall(resp) # Send RXd data out on client socket
        print("Sent {} byte payload out socket to client.".format(len
(resp)))

def SockReaderThread():
    """
    This thread listens to the MQTT client's socket and upon receiving a
    payload, it sends this data out on the defined serial port ('ser') to
    the
    modem for transmission.
    """

    global clisock
    while (1):
        data = clisock.recv(4096) # RX data from client socket
        # If the RECV call returns 0 bytes, the socket has closed
        if (len(data) == 0):
            print("ERROR - socket has closed. Exiting socket reader
thread.")
            return 1 # Exit the thread to avoid a loop of 0-byte
receptions
        else:

```

```

        print("Received {} bytes from client via socket.".format(len
(data)))
        print("Sending payload to modem...")
        bytes_wr = ser.write(data) # Write payload to modem via
UART/serial
        print("Wrote {} bytes to modem".format(bytes_wr))

def main():
    setup() # Setup the serial port and socket
    global clisock, svrsock
    if (not clisock): # Accept a connection on 'svrsock' to open
'clisock'
        print("Awaiting ACCEPT on server sock...")
        (clisock, cliaddr) = svrsock.accept() # Accept an incoming
connection
        print("Connection accepted on socket")
        # Make thread for ComReader
        comthread = threading.Thread(target=ComReaderThread)
        comthread.start() # Start the thread
        # Make thread for SockReader
        sockthread = threading.Thread(target=SockReaderThread)
        sockthread.start() # Start the thread

main()

```

Note This script is a general TCP-UART proxy, and can be used for other applications or scripts that use the TCP protocol. Its functionality is not limited to MQTT.

Note You can easily copy and paste code from the [online version of this guide](#). Use caution with the PDF version, as it may not maintain essential indentations.

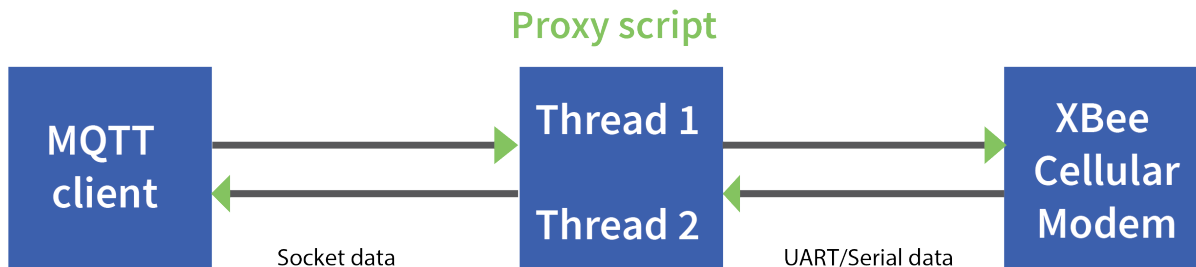
This proxy script waits for an incoming connection on localhost (127.0.0.1), on port 17300. After accepting a connection, and creating a socket for that connection (**clisock**), it creates two threads, one that reads the serial or COM port that the XBee Cellular Modem is connected to, and one that reads the socket (**clisock**), that the MQTT client is connected to.

With:

- The proxy script running
- The MQTT client connected to the proxy script via localhost (127.0.0.1)
- The XBee Cellular Modem connected to the machine via USB and properly powered
- AP, DL, and DE set correctly

the proxy acts as an intermediary between the MQTT client and the XBee Cellular Modem, allowing the MQTT client to use the data connection provided by the device.

Think of the proxy script as a translator between the MQTT client and the XBee Cellular Modem. The following figure shows the basic operation.



The thread that reads the serial port forwards any data received onward to the client socket, and the thread reading the client socket forwards any data received onward to the serial port. This is represented in the figure above.

The proxy script needs to be running before running an MQTT publish or subscribe script.

1. With the proxy script running, run the subscribe example from [Example: receive messages \(subscribe\) with MQTT](#), but change the connect line from `client.connect("m2m.eclipse.org", 1883, 60)` to `client.connect("127.0.0.1", port=17300, keepalive=20)`. This connects the MQTT client to the proxy script, which in turn connects to a broker via the XBee Cellular Modem's internet connection.
2. Run the publish example from [Example: send messages \(publish\) with MQTT](#) in a third Python instance (while the publish script is running you will have three Python scripts running at the same time).

The publish script runs over your computer's normal Internet connection, and does not use the XBee Cellular Modem. You are able to see your published message appear in the subscribe script's output once it is received from the broker via the XBee Cellular Modem. If you watch the output of the proxy script during this process you can see the receptions and transmissions taking place.

The proxy script must be running before you run the subscribe and publish scripts. If you stop the subscribe script, the socket closes, and the proxy script shows an error. If you try to start the proxy script after starting the subscribe script, you may also see a socket error. To avoid these errors, it is best to start the scripts in the correct order: proxy, then subscribe, then publish.

Update the firmware

You should update your XBee to the latest firmware to take advantage of all the latest fixes and features. Refer to the topics below for information about the available update methods.

Digi strongly recommends that you devise a plan to update the firmware after initial deployment. For more information, see [Create a plan for device firmware updates](#).

Create a plan for device component firmware updates

You should update your XBee to the latest firmware to take advantage of all the latest fixes and features. Security issues or software bugs may be identified which require firmware updates to resolve. In addition, Digi periodically releases new device firmware which includes new features and improves reliability and performance of existing features. You should evaluate and test the new releases and update your firmware to take advantage of the improvements and new features.

Note For Cellular 3G modems, you cannot update the firmware on the cellular component.

Note Digi will not accept responsibility for customers who have not planned to update their units. Please review the information provided below.

Please review the suggestions below:

- If updates will be performed using a PC, XBee Studio version 1.2.0 or later is able to perform device firmware updates.
- If updates will be performed using a host processor, see [Use a host processor to update the modem firmware for XBee devices over UART](#).
- If updates will be performed over-the-air (OTA):
 - If your XBee application is using API mode, monitor for [Modem Status \(0x8A\)](#) API frames with status codes 0x38 through 0x3A. These modem status frames inform the XBee's host application about ongoing and completed or failed firmware updates.
 - If your XBee application is using [Transparent mode](#), test your application to determine whether it is tolerant to over-the-air firmware updates of the cellular component and XBee firmware. If your application cannot tolerate the network connection being non-functional for up to 30 minutes (for example, if the XBee will be reset in a shorter time than that), do not use over-the-air updates, and be aware that firmware updates to the XBee require user intervention.
 - If the XBee firmware is updated over-the-air using Digi Remote Manager: After the new firmware image has been downloaded and validated, the XBee modem reboots

automatically to install the firmware. The XBee then resets into the new firmware once the update is complete, which may take up to 60 seconds.

Update the device firmware

You should update the device firmware on your XBee to the latest version to take advantage of all the latest fixes and features. Security issues or software bugs may be identified which require firmware updates to resolve. In addition, Digi periodically releases new firmware which includes new features and improves reliability and performance of existing features.

The table below lists update methods you can use and the instructions for each method.

Method	Instructions
XBee Studio	Update the device firmware using XBee Studio
Firmware Over the Air (Digi Remote Manager) (FOTA (DRM))	▪ Update the firmware from the Devices page in Remote Manager ▪ Update the firmware using web services in Remote Manager ▪ Schedule a task to update the device firmware using Remote Manager
API	Use a host processor to update the modem firmware for XBee devices over UART

Update the device firmware using XBee Studio

You can use XBee Studio to update the device firmware.

Prerequisites

- Windows PC
- Digi XBee Studio version 1.2.0 or newer. You should [upgrade XBee Studio](#) to the latest version.
- Make sure the device is added to XBee Studio (this should happen automatically).

To update the device firmware:

1. Launch XBee Studio .
2. Navigate to the firmware update page by one of the following methods:
 - Hover over your device and then click **Open Firmware Update**.
 - Click on your device and then click **Firmware Update** in the left menu.
 - Click **Configuration** in the sidebar, then click **Firmware Update**, then finally click on your device.
3. Click **Update firmware**. The **Update the radio module firmware** dialog appears and displays the available and compatible device firmware for the selected XBee module.
4. Make sure you check the **Force the module to maintain its current configuration** box.
5. Select the product family of the XBee module, the function set, and the latest firmware version.

6. Click **Update**. A dialog displays update progress. Click **Show details** for details of the firmware update process.

For more information, see [Firmware Update](#) in the *XBee Studio User Guide*.

Update the firmware from the Devices page in Remote Manager

You can update the device firmware for one or multiple devices from the **Devices** page in Remote Manager.

Before you begin, verify the TCP connection method your device uses to connect to Remote Manager: query once a day or use a persistent TCP connection. See [TCP connection](#).

To perform a firmware update:

1. Download the updated firmware file for your device from Digi's support site.
 - a. Go to the [Digi XBee Cellular 3G support page](#).
 - b. Scroll down to the **Firmware Updates** section.
 - c. Locate and click **XBee Cellular 3G AT&T Global Firmware** to download the zip file.
 - d. Unzip the file.
2. Set up a persistent connection to connect the device to Remote Manager. See [Set up a persistent connection to a remote XBee](#).
3. [Log into Remote Manager](#).
4. Click **Devices** in the left pane.
5. Select the first device you want to update. To select multiple devices (all devices must be of the same type), press the Control key and select additional devices.
6. From the toolbar at the top of the screen, click **Actions**. Scroll down and click **Update Firmware**. The **Update Firmware** dialog appears.
7. Make sure **Update Firmware File** is selected in the list box. This is the default.
8. Click **Choose File** to select the .ebin file that you unzipped earlier.
9. Click **Update**. The updated devices automatically reboot when the updates are complete.

Note The update is immediately rejected and an error is returned if the device is going into sleep mode or is being shut down. See [Clean shutdown](#).

10. When all changes are complete, [disconnect the device](#) from Remote Manager.

Update the firmware using web services in Remote Manager

Remote Manager supports both synchronous and asynchronous firmware update using web services. The following examples show how to perform an asynchronous firmware update. See the Remote Manager [documentation](#) for more details on firmware updates.

Before you begin, verify the TCP connection method your device uses to connect to Remote Manager: query once a day or use a persistent TCP connection. See [TCP connection](#).

Note You must use XBee Studio to update the cellular component's firmware.

1. Download the updated firmware file for your device from Digi's support site.
 - a. Go to the [Digi XBee Cellular 3G support page](#).
 - b. Scroll down to the **Firmware Updates** section.
 - c. Locate and click **XBee Cellular 3G AT&T Global Firmware** to download the zip file.
 - d. Unzip the file and locate the .ebin file in the unzipped directory.
2. Send an HTTP SCI request to Remote Manager with the contents of the downloaded .ebin file converted to base64 data. Refer to the the following examples:

Examples for .ebin:

- [Example: Update the XBee firmware synchronously using a local file](#)
- [Example: Update the XBee firmware synchronously using a Remote Manager Data File](#)

Example: Update the XBee firmware synchronously using a local file

```
import base64
import requests

# Location of firmware image
firmware_path = 'XBXC.ebin'

# Remote Manager device ID of the device being updated
device_id = '00010000-00000000-03526130-70153378'

# Remote Manager username and password
username = "my_Remote_manager_username"
password = "my_remote_manager_password"

url = 'https://remotemanager.digi.com/ws/sci'

# Get firmware image
fw_file = open(firmware_path, 'rb')
fw_data = fw_file.read()
fw_data = base64.encodebytes(fw_data).decode('utf-8')

# Form update_firmware request
data = """
<sci_request version="1.0">
  <update_firmware filename="firmware.ebin">
    <targets>
      <device id="{}/>
    </targets>
    <data>{}</data>
  </update_firmware>
</sci_request>
""".format(device_id, fw_data)

# Post request
r = requests.post(url, auth=(username, password), data=data)
if (r.status_code != 200) or ("error" in r.content.decode('utf-8')):
    print("firmware update failed")
else:
    print("firmware update success")
```

Example: Update the XBee firmware synchronously using a Remote Manager Data File

To update the XBee firmware synchronously with Python 3.0, but using the device firmware image already uploaded to Remote Manager, upload the device's *.ebin firmware to Remote Manager:

1. Download the updated firmware file for your device from [Digi's support site](#). This is a zip file containing .ebin and .mxi files for import.
2. Unzip the file and locate the .ebin inside the unzipped directory.
3. Log in to Remote Manager.
4. Click the **Data Services** tab.
5. Click **Data Files**.
6. Click **Upload Files**; browse and select the *.ebin firmware file to upload it.
7. Send an HTTP SCI request to Remote manager with the path of the .ebin file; see the example below.

```
import base64
import requests

# Location of firmware image on Remote Manager
firmware_path = '~/XBXC.ebin'

# Remote Manager device ID of the device being updated
device_id = '00010000-00000000-03526130-70153378'

# Remote Manager username and password
username = "my_remote_manager_username"
password = "my_remote_manager_password"

url = 'https://remotemanager.digi.com/ws/sci'

# Form update_firmware request
data = """
<sci_request version="1.0">
  <update_firmware filename="firmware.ebin">
    <targets>
      <device id="{}/>
    </targets>
    <file>{}</file>
  </update_firmware>
</sci_request>
""".format(device_id, firmware_path)

# Post request
r = requests.post(url, auth=(username, password), data=data)
if (r.status_code != 200) or ("error" in r.content.decode('utf-8')):
    print("firmware update failed")
else:
    print("firmware update success")
```

Use a host processor to update the modem firmware for XBee devices over UART

This process explains how to update the modem firmware for XBee Cellular devices.

Update the modem firmware

1. Make sure you have the correct version of the modem firmware for your XBee device.
2. Enter programming (bootloader) mode. Use one of the following methods: AT commands or hardware signaling.

- **AT commands**

- a. Send the %P command. The %P command must be sent an argument derived from the SL parameter of the module being updated. The argument is the value of SL added to the value 0xDB8A and then masked by performing a bitwise-AND with 0x3FFF.

- i. Run ATSL to get the address value, which is in hex.

```
ATSL
123456
```

- ii. Add bitwise-AND with 0x3FFF.

```
(0xDB8A + 0x123456) & 0x3FFF = 0x0FE0
```

- iii. Send the command AT%PFE0.

```
AT%PFE0
```

- b. You will receive an error, which is expected.
- c. Send the [FR command](#) to reboot and enter into bootloader.

- **Invoke the bootloader with hardware signaling**

- a. De-Assert RTS (pin 16).
- b. Assert DTR (pin 9).
- c. Put DIN in a low state (break) (pin 3).
- d. Reset the module (pin 5).
- e. Release the break on DIN (pin 3) The module should now be in bootloader at 38400 baud.

3. Once the module is in programming (bootloader) mode, configure the local serial port to 38400/8/N/1.
4. Get the hardware version of the radio module from the bootloader.

- a. Send the V command. The response to that command has the following format:

<pre> XXXXXXXXXXZZAABBBBCCCCCCCCCCCCCCCC C </pre>	▪ XXXX: The hardware version. See ATHV, little endian. ▪ YYYY: The hardware revision. See <code>AT%R</code>, little endian. ▪ ZZ: The hardware compatibility number. See <code>AT%C</code>. ▪ AA: Unused and should be 0. ▪ BBBB: The hardware series. See ATHS, little endian. ▪ CCCCCCCCCCCCCCCC: The serial number.
---	---

5. If possible, change the baud rate of the serial port to optimize the firmware update process. Send the X command to the bootloader.
 - The bootloader answers with the maximum supported baud rate (in ASCII) and, just after that, the bootloader changes its baud rate to that value. Change your baud rate to match the max supported rate.
 - If the bootloader does not answer to this command, remain at the current rate.
6. Send the I command (initialization command). This command erases the current firmware from the device.
7. Transfer the firmware to the device using the transfer protocol shown below.

Transfer the firmware to the device

1. You must split the file into 512 byte blocks.
2. Transfer each block using the following structure, with block index and CRC16 sent in little endian byte:

P [2 bytes for block index] [block data with page size length] [2 bytes for CRC16]

Note CRC16 is calculated only with the bytes of the page to be sent, and is initialized with 0x0000. The polynomial used for the CRC16 is 0x8005.

3. After each block is transfered, wait for a response. Options are:
 - 0x55 - ACK: This is the expected answer.
 - 0x12: Checksum/CRC16 error.
 - 0x13: Flash write/verify error.

Note If an error occurs, you may try to transfer each block up to three times.

4. Verify and write the firmware to flash.
 - a. Send the C command (verify) to verify and write the firmware to the flash.
 - b. Verify that the answer to this command is 0x55 (ACK). Any other result is an error.
5. Wait a couple of seconds for the firmware to be installed and start running.

Technical specifications

Interface and hardware specifications

The following table provides the interface and hardware specifications for the device.

Specification	Value
Dimensions	2.438 x 3.294 cm (0.960 x 1.297 in)
Weight	5 g (0.18 oz)
Operating temperature	-40 to +85 °C -30 to +70 °C if 2G fallback mode is enabled
Antenna connector	U.FL
Digital I/O	13 I/O lines
ADC	4 10-bit analog inputs

RF characteristics

The following table provides the RF characteristics for the device.

Specification	Value
Transmit power	Up to 24 dBm, Power Class 3 2G fallback: up to 33 dBm, Power Class 4
Receive sensitivity	Up to -111 dBm

Networking specifications

The following table provides the networking and carrier specifications for the device.

Specification	Value
Addressing options	TCP/IP, UDP, and SMS

Specification	Value
Technology	3G Universal Mobile Telecommunications Service (UMTS)/High Speed Packet Access (HSPA) with 2G fallback ¹
Supported bands	Band 19 (800 MHz) Band 5 (850 MHz) Band 8 (900 MHz) Band 2 (1900 MHz) Band 1 (2100 MHz)
Security	Digi Trustfence™ security with secure boot, encrypted storage, protected JTAG, TLS 1.2
Downlink/uplink speeds	Up to 7.2 Mb/s / 5.76 Mb/s

Power requirements

The following table provides the power requirements for the device.

Specification	Value
Normal supply voltage range	3.0 to 5.5 VDC (3.8 to 5 V for 2G fallback mode)
Extended supply voltage range ²	2.7 to 5.5 VDC (3.6 to 5.5 VDC for 2G fallback mode)

Power consumption

The peak current was measured from multiple tested units.

Specification	State	Average current (3G mode)
Connected mode (TX + RX) current	Active transmit, 24 dBm @ 3.3 V	702 mA
Tx + RX current	Active transmit, 24 dBm @ 5.0 V	425 mA
Rx + ACK current	Active receive @ 3.3 V	224 mA
Rx + ACK current	Active receive @ 5 V	160 mA
Idle current	Idle/connected, listening @ 3.3 V	87 mA
Idle current	Idle/connected, listening @ 5 V	72 mA
Sleep current	Not connected, Deep Sleep @ 3.3 V	10 µA

¹See [DO \(Device Options\)](#) for more information on enabling and using the 2G fallback feature.

²See the [2G fallback](#) power consumption table for further details.

Electrical specifications

The following table provides the electrical specifications for the XBee Cellular Modem.

Symbol	Parameter	Condition	Min	Typical	Max	Units
VCC_IO	Internal supply voltage for I/O	While in deep sleep and during initial power up	VCC - 0.3 V or 3.3 V, whichever is lower		3.3	V
VCC_IO	Internal supply voltage for I/O	In normal running mode		3.3 V		V
VI	Input voltage range on any I/O pin		-0.3		VCC_IO + 0.3	V
VIL	Input low voltage				0.3*VCC_IO	V
VIH	Input high voltage		0.7*VCC_IO			V
VOL	Voltage output low	Sinking 1 mA, VCC_IO = 3.3 V		0.05*VCC_IO		V
VOH	Voltage output high	Sourcing 1 mA, VCC_IO = 3.3 V		0.9*VCC_IO		V
I_IN	Input leakage current on I/O pins	High Z state; I/O connected to Ground or VCC_IO		0.1	100	nA
RPU	Internal pull-up resistor	Enabled		40		kΩ
RPD	Internal pull-down resistor	Enabled		40		kΩ

Regulatory approvals

The following table provides the regulatory and carrier approvals for the device.

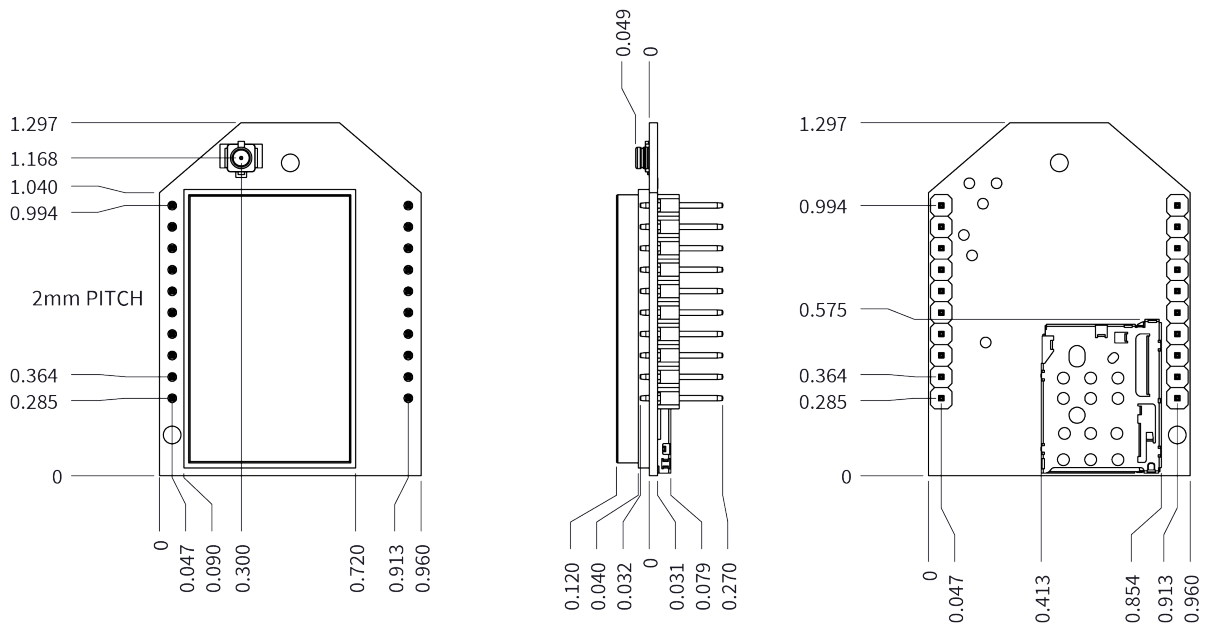
Specification	Value
United States	Contains FCC ID: XPY1CGM5NNN
Innovation, Science and Economic Development Canada (ISED)	Contains IC: 8595A-1CGM5NNN
Europe (CE)	Yes
Australia ACMA	Yes, RCM
New Zealand RSM	Yes, R-NZ
RoHS	Lead-free and RoHS compliant
PTCRB certification	No
AT&T end device certified	Yes

Hardware

Mechanical drawings

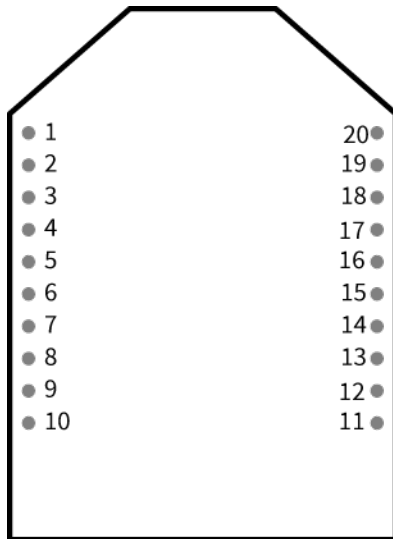
The following figures show the mechanical drawings for the XBee Cellular Modem. All dimensions are in inches.

For XBee header information, see [XBee header connector requirements](#).



Pin signals

The pin locations are:



The following table shows the pin assignments for the through-hole device. In the table, low-asserted signals have a horizontal line above signal name.

Pin	Name	Direction	Default	Description
Pin	Name	Direction	Default	Description
1	V _{CC}			Power supply
2	DOUT	Output	Output	UART Data Out
3	DIN / $\overline{\text{CONFIG}}$	Input	Input	UART Data In
4	DIO12 / SPI_MISO	Either	Disabled	Digital I/O 12 or SPI Slave Output line
5	$\overline{\text{RESET}}$	Input		
6	PWM0 / RSSI / DIO10	Either	Output	PWM Output 0 / RX Signal Strength Indicator / Digital I/O 10
7	DIO11	Either	Disabled	Digital I/O 11
8	[reserved]			Do not connect
9	$\overline{\text{DTR}}$ / SLEEP_RQ / DIO8	Either	Disabled	Pin Sleep Control Line or Digital I/O 8
10	GND			Ground
11	DIO4 / SPI_MOSI	Either	Disabled	Digital I/O 4 or SPI Slave Input Line
12	$\overline{\text{CTS}}$ / DIO7	Either	Output	Output Clear-to-Send Flow Control or Digital I/O 7

Pin	Name	Direction	Default	Description
13	ON / $\overline{\text{SLEEP}}$ /DIO9	Output	Output	Module Status Indicator or Digital I/O 9
14	VREF	-		Feature not supported on this device. Used on other XBee devices for analog voltage reference.
15	Associate / DIO5	Either	Output	Associated Indicator, Digital I/O 5
16	$\overline{\text{RTS}}$ / DIO6	Either	Disabled	Input Request-to-Send Flow Control, Digital I/O 6
17	AD3 / DIO3 / SPI_ $\overline{\text{SS}}$	Either	Disabled	Analog Input 3 or Digital I/O 3, SPI low enabled select line
18	AD2 / DIO2 / SPI_CLK	Either	Disabled	Analog Input 2 or Digital I/O 2, SPI Clock line
19	AD1 / DIO1 / SPI_ $\overline{\text{ATTN}}$	Either	Disabled	Analog Input 1 or Digital I/O 1, SPI Attention line output
20	AD0 / DIO0	Either	Input	Analog Input 0, Digital I/O 0

Pin connection recommendations

The recommended minimum pin connections are VCC, GND, DIN, DOUT, $\overline{\text{RTS}}$, $\overline{\text{DTR}}$ and $\overline{\text{RESET}}$. Firmware updates require access to these pins.

XBee header connector requirements

The XBee header connectors require the following attributes:

- female
- 2 mm pitch
- 10 positions
- single row

RSSI PWM

The XBee Cellular Modem features an RSSI/PWM pin (pin 6) that, if enabled, adjusts the PWM output to indicate the signal strength of the cellular connection. Use [P0 \(DIO10/PWM0 Configuration\)](#) to enable the RSSI pulse width modulation (PWM) output on the pin. If **P0** is set to 1,

the RSSI/PWM pin outputs a PWM signal where the frequency is adjusted based on the received signal strength of the cellular connection.

The RSSI/PWM output is enabled continuously unlike other XBee products where the output is enabled for a short period of time after each received transmission. If running on the XBIB development board, DIO10 is connected to the RSSI LEDs, which may be interpreted as follows:

PWM duty cycle	Number of LEDs turned on	Received signal strength (dBm)
79.39% or more	3	-83 dBm or higher
62.42% to 79.39%	2	-93 to -83 dBm
45.45% to 62.42%	1	-103 to -93 dBm
Less than 45.45%	0	Less than -103 dBm, or no cellular network connection

SIM card

The XBee Cellular Modem uses a 4FF nano-SIM card. The SIM interface supports only 1.8 V SIM types.



CAUTION! Never remove the SIM card while the power is on!

Associate LED functionality

The following table describes the Associate LED functionality. For the location of the Associate LED on the XBIB-U development board, see number 6 on the [XBIB-U-DEV reference](#).

LED status	Blink timing	Meaning
On, solid		Not joined to a mobile network.
Double blink	½ second	The last TCP/UDP/SMS attempt failed. If the LED has this pattern, you may need to check DI (Remote Manager Indicator) or CI (Protocol/Connection Indication) for the cause of the error. Note This pattern applies only to the Transparent mode. Other transmission modes do not affect the Associate LED blink pattern.
Standard single blink	1 second	Normal operation.

The normal association LED signal alternates evenly between high and low as shown below:



Where the low signal means LED off and the high signal means LED on.

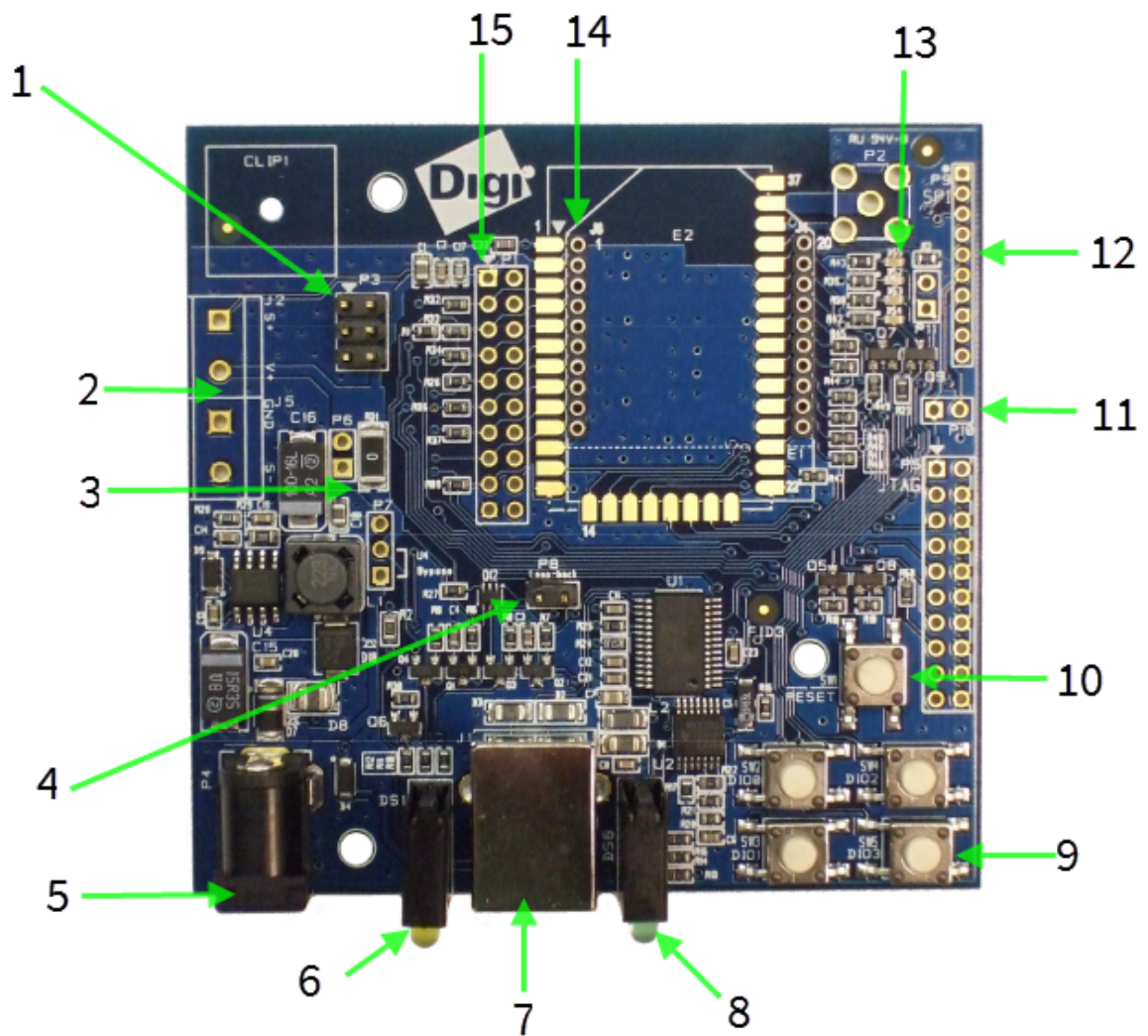
When **CI** is not **0** or **0xFF**, the Associate LED has a different blink pattern that looks like this:



Development boards

XBIB-U-DEV reference

This picture shows the XBee USB XBIB-U-DEV development board and the table that follows explains the call-outs in the picture.



Number	Item	Description
1	Programming header	Header used to program XBee programmable devices.
2	Self power module	Advanced users only—voids the warranty. Depopulate R31 to power the device using V+ and GND from J2 and J5. You can connect sense lines to S+ and S- for sensing power supplies.  CAUTION: Voltage is not regulated. Applying the incorrect voltage can cause fire and serious injury.¹
3	Current testing	Depopulating R31 allows a current probe to be inserted across P6 terminals. The current though P6/R31 powers the device only. Other supporting circuitry is powered by a different trace.
4	Loopback jumper	Populating P8 with a loopback jumper causes serial transmissions both from the device and from the USB to loopback.
5	DC barrel plug: 6-20 V	Greater than 500 mA loads require a DC supply for correct operation. Plug in the external power supply prior to the USB connector to ensure that proper USB communications are not interrupted.
6	LED indicator	Yellow: Modem sending serial/UART data to host. Green: Modem receiving serial/UART data from host. Red: Associate.
7	USB	Connects to your computer.
8	RSSI indicator	See RSSI PWM . On the XBIB-U, more lights are better.
9	User buttons	Connected to DIO lines for user implementation.
10	Reset button	Press the reset button to reset the device to the default configuration.
11	SPI power	Connect to the power board from 3.3 V.
12	SPI	Only used for surface-mount devices.
13	Indicator LEDs	DS5: ON/SLEEP DS2: DIO12, the LED illuminates when driven low. DS3: DIO11, the LED illuminates when driven low. DS4: DIO4, the LED illuminates when driven low.
14	Through-hole XBee sockets	

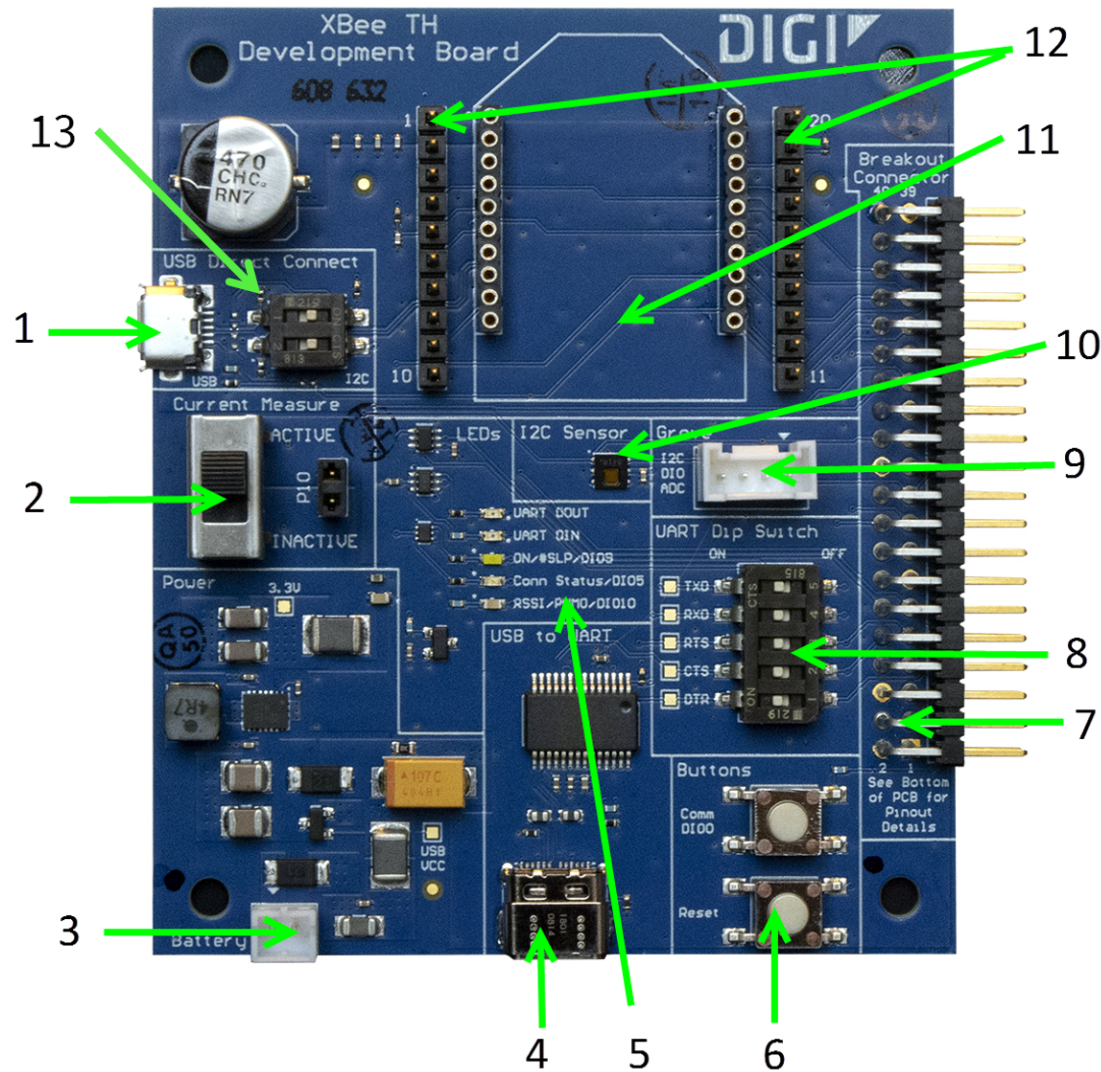
¹Powering the board with J2 and J5 without R31 removed can cause shorts if the USB or barrel plug power are connected. Applying too high a voltage destroys electronic circuitry in the device and other board components and/or can cause injury.

Number	Item	Description
15	20-pin header	Maps to standard through-hole XBee pins. Male, Samtec header, part number: TSW-110-26-L-D. 2.54 mm / .100" pitch and row spacing.

XBIB-CU-TH reference

This picture shows the XBIB-CU-TH development board and the table that follows explains the callouts in the picture.

Note This module is sold separately or in our XBee3 Cellular Kits.



Number	Item	Description
1	USB Direct Connect (USB MICRO B) and DIP Switch	The USB Direct connector allows for direct connection to the cellular module on the XBee. This connection is the fastest method of upgrading the cellular modem firmware and allows for development of applications that directly interface to the cellular modem.

Number	Item	Description
		The USB Direct connector is always connected to the pins 7 and 8 of the XBee module. For reliable USB communication to the cellular modem, the dual in-line package (DIP) switches must be in the OFF (left) position, which disconnects pins 7 and 8 of the XBee module from the breakout header and from the inter-integrated circuit (I²C) bus. To use I²C, the DIP switches must be in the ON (right) position and the USB micro B cable should be disconnected. Note This USB connector will not power device. Use USB-C to power the device.  WARNING! If the DIP switches are left ON while making a USB Direct connection, the cellular modem may enumerate on a computer, but communication to the modem will be unreliable.  WARNING! USB Direct port should not be connected when used with XBees that do not support USB communications.
2	Current Measure	The switch allows the XBee VCC pin to disconnected from the 3.3V supplied by the XBIB. When in the INACTIVE (downward) position, the XBIB powers the XBee normally. When in the ACTIVE position, power must be delivered via jumper P10. This allows current measurements to be conducted by attaching a current meter across the jumper P10. Note The USB-to-serial communications connection may affect this current measurement.
3	Battery Connector	If desired, a battery or other power source can be attached to provide power to the development board. The voltage can range from 2 V to 5.5 V. The positive terminal is on the left. If the USB-C connector is connected to a computer, the power will be provided through the USB-C connector and not the battery connector.  WARNING! Battery current discharge rating must be enough to support 5 W or more.

Number	Item	Description
		 WARNING! There is no circuit to prevent over discharge of battery. Battery must contain its own protection circuitry.
		 WARNING! Move UART switches to the OFF position when using battery or external power or for when the XBee and the USB-C connector is not powering the UART.
		The USB to UART converter is powered only via the USB-C connection. Note While the battery voltage can vary from 2V to 5V, the XBIB-CU-TH will regulate that voltage to 3.3V for the XBee. Lower input voltages will require higher input currents to supply the necessary power to the XBee and any attached devices.
4	USB-C Connector	Provides power for the XBee and development board as well as serial communications to the XBee. Note To run XBee Cellular modules requires connecting this to a USB 3.0 capable port (usually a blue port) due to the power requirements. Connecting to a USB 2.0 port will result in unreliable operation.
5	LED indicator	Red: UART DOUT (modem sending serial/UART data to host) Green: UART DIN (modem receiving serial/UART data from host) White: ON/SLP/DIO9 Blue: Connection Status/DIO5 Yellow: RSSI/PWM0/DIO10
6	User Buttons	Comm DIO0 Button connects the Commissioning/DIO0 pin to GND when pressed. Note The XBee Cellular does not implement any commissioning function like other XBees. Connection to the cellular network is automatic when a SIM card is inserted and the modem is powered on. RESET button resets the XBee module when pressed.
7	Breakout Connector	This 40 pin connects to various XBee pins as shown on the silkscreen on the bottom of the board. See XBIB-C Development Boards for details.
8	UART Dip	Push DIP switches to the right (OFF position) to disconnect the

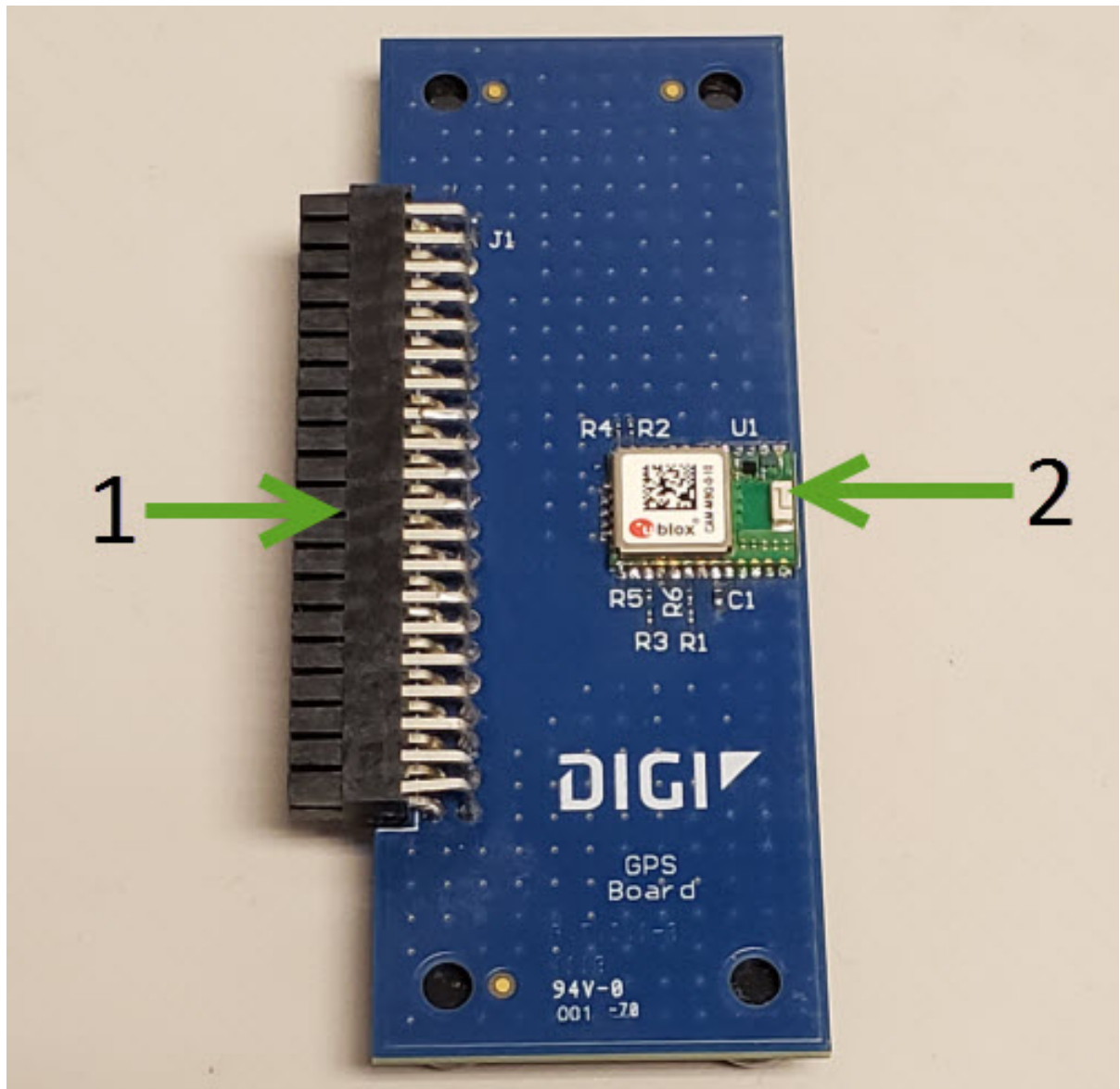
Number	Item	Description
	Switch	XBee from the USB-to-serial converter. The USB-to-serial converter should be disconnected from the XBee to use the serial lines on the breakout connector, when taking current measurements, or when powering the XBIB from the Battery Connector.
9	Grove Connector	This connector attaches I²C-enabled devices to the development board. The XBee3 devices all include I²C. Move both USB direct connect switches to the right (closed position) and disconnect the USB micro port for correct operation of the I²C to connector. - Pin 1: I²C_CLK/XBee DIO1 - Pin 2: I²C_SDA/XBee DIO11 - Pin 3: VCC - Pin 4: GND
10	Temp/Humidity Sensor	This part is a Texas Instruments HDC1080 temperature and humidity sensor connected through I²C on XBee pins DIO1 and DIO11. For correct operation of the I²C sensor, both USB direct connect switches must be to the right (closed position) and be sure to disconnect the USB micro port.
11	XBee Socket	This is the socket for the XBee (through-hole (TH) form factor).
12	XBee Test Point Pins	Allows easy access to pins 1 to 20 of the XBee.
13	Switches	The switch position varies, depending on the feature you are using. - USB direct mode: Both switches must be in the left position. For more information, see Connect the hardware for USB Direct mode. - I²C sensor: Both switches must be in the right position. See item 10, Temp/Humidity Sensor.

XBIB-C-GPS reference

This picture shows the XBIB-C-GPS module and the table that follows explains the callouts in the picture.

Note This GPS module is sold separately and requires an [XBIB-CU-TH development board](#).

Note You run a demo using MicroPython to parse UART to GPS communications. See [Run the MicroPython GPS demo](#).



Number	Item	Description
1	40-pin header	This header is used to connect the XBIB-C-GPS board to a compatible XBIB development board. Insert the XBIB-C-GPS module slowly with alternating pressure on the upper and lower parts of the connector. Do not bend pins during insertion or removal process.
2	GPS unit	Contains GPS module CAM-M8Q-0-10. Proper orientation is with the board laying flat, with the GPS module having a clear view of the sky.

Interface with the XBIB-C-GPS module

The XBee Cellular Modem can interface with the XBIB-C-GPS board through the 40-pin header. This header is designed to fit into XBIB-C development board. This allows the XBee Cellular Modem in the XBIB-C board to communicate with the XBIB-C-GPS board—provided the XBee device has MicroPython capabilities (see [this link](#) to determine which devices have MicroPython capabilities). There are two ways to interface with the XBIB-C-GPS board: through the host board's Secondary UART or through the I²C compliant lines.

The following picture shows a typical setup:



I²C communication

There are two I²C lines connected to the host board through the 40-pin header, SCL and SDA. I²C communication is performed over an I²C-compliant Display Data Channel. The XBIB-C-GPS module operates in slave mode. The maximum frequency of the SCL line is 400 kHz. To access data through the I²C lines, the data must be queried by the connected XBee Cellular Modem.

For more information about I²C Operation see the **I²C** section of the [Digi Micro Python Programming Guide](#).

For more information on the operation of the XBIB-C-GPS board see the [CAM-M8 datasheet](#). Other CAM-M8 documentation is located [here](#).

UART communication

UART (RX and TX) are pins connected from the XBIB-C-GPS to the host board by the 40-pin header. By default, the UART on the XBIB-C-GPS board is active and sends GPS readings once every second. The baud rate of the UART is 9600 baud.

For more information about using Micro Python to communicate to the XBIB-C-GPS module, see [Class UART](#).

Run the MicroPython GPS demo

The Digi MicroPython github repository contains a GPS demo program that parses the GPS NMEA data from the UART and prints them.

Note If you are unfamiliar with MicroPython on XBee, see [Get started with MicroPython](#). For more detailed information, refer to the [Digi MicroPython Programming Guide](#).

Step 1: Clone or download the XBee MicroPython repository

1. Navigate to: <https://github.com/digidotcom/xbee-micropython/>.
2. You must either clone or download a zip file of the repository. You can use either method.
 - **Clone:** If you are familiar with Git, follow the standard Git process to clone the repository.
 - **Download**
 - a. Click **Download zip** to download a zip file of the repository to the download folder of your choosing.
 - b. Extract the repository to a location of your choosing on your hard drive.

Step 2: Edit the MicroPython file

1. Navigate to the location that you created in Step 1.
2. Navigate to: **samples/gps_uart**.
3. Open the MicroPython file: *main.py*.

Step 3: Run the program

1. [Copy the file](#) onto your device's root filesystem directory.
2. Open [XBee Studio](#) and use the MicroPython Terminal to run the demo.
3. Type <CTRL>-R from the MicroPython prompt to run the code.

Antenna recommendations

For additional antenna regulatory requirements, refer to:

- [Antenna regulatory information: FCC and ISSED](#)

Antenna placement

For optimal cellular reception, follow the antenna manufacturer's recommendations. In general, keep the antenna as far away from metal objects and other electronics (including the XBee Cellular Modem) as possible. See [Antenna regulatory information: FCC \(US\)](#) for limitations on antenna placement. Often, small antennas are desirable, but come at the cost of reduced range and reduced battery life.

Design recommendations

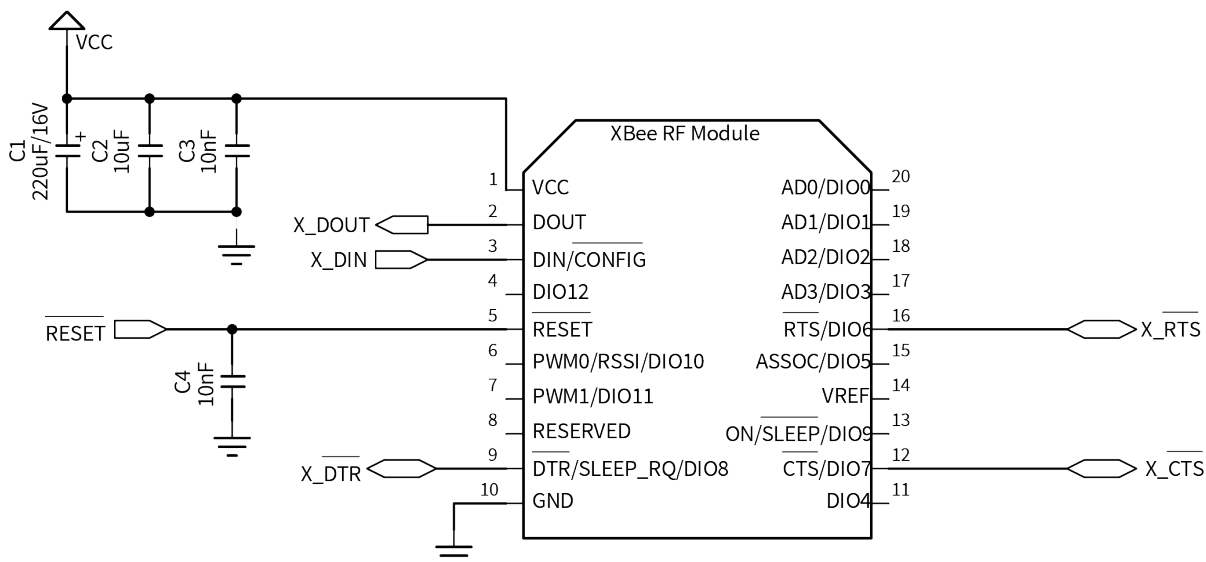
Power supply considerations

When considering a power supply, use the following design practices.

1. Power supply ripple should be less than 75 mV peak to peak.
2. The power supply should be capable of providing a minimum of 1.5 A at 3.3 V (5 W). Keep in mind that operating at a lower voltage requires higher current capability from the power supply to achieve the 5 W requirement.
3. Place sufficient bulk capacitance on the XBee VCC pin to maintain voltage above the minimum specification during inrush current. Inrush current for VCC = 3.3 V is about 2 A during initial power up of cellular communications and wakeup from sleep mode. We recommend a minimum of 220 μ F of capacitance on the VCC pin.
4. Place a 10 nF ceramic capacitor very close to the XBee Cellular Modem VCC pin to decrease high frequency noise.
5. Use a wide power supply trace or power plane to ensure it can handle the peak current requirements with minimal voltage drop. We recommend that the power supply and trace be designed such that the voltage at the XBee VCC pin does not vary by more than 0.1 V between light load ($\sim$ 0.5 W) and heavy load ($\sim$ 3 W).
6. If you use [DO \(Device Options\)](#) to enable 2G fallback mode, the power supply must be capable of supplying 11.5 W and the minimum input voltage is 3.8 V (for example 3.0 A @ 3.8 V). In addition, we recommend 1000 μ F of bulk capacitance on the VCC pin. The supply should never drop below 3.6 V during TX bursts.

Add a capacitor to the RESET line

In high EMI noise environments, we recommend adding a 10 nF ceramic capacitor very close to pin 5.



Heat considerations

Depending on the use case, your application may require a heat sink. Use a non-conductive thermal gasket to make contact to the heat sink. The gasket should be thick enough to ensure that contact with the tallest component does not cause damage when pressure is applied to a secure heat sink.

We recommend connecting the heat sink to the bottom side of the XBee Cellular Modem (SIM card side). Alternatively, you can attach the heat sink to the top side of the unit (U.FL side), but cooling is less effective on this side.

We do not recommend operating at hot temperatures without verifying that the device will not overheat in the operating circumstances.

The operation temperature of the unit can be approximated for different current draws and extreme cases by the equation below. For best results, attach a temperature probe on the bottom of the XBee Cellular Modem, about 5 mm higher than the SIM card slot. Alternatively use [TP \(Temperature\)](#) to query the current temperature of the device's processor.

Where

1. *XBeeBoardTemp* is the temperature of the XBee Cellular Modem at steady state.
 - a. Use the [TP](#) command to help estimate the temperature when attaching a temperature probe is not practical, but for reliable results, you must use a temperature probe.
2. *RoomTemp* is the temperature of the ambient air.
3. *AverageCurrentDuringTest* is the average current measured during test.
4. *ScenarioMaxCurrent* is the maximum current expected for the device.

The results may vary by implementation and scenario. You should always perform sufficient testing to ensure that the XBee Cellular Modem does not exceed temperature specifications.

Add a fan to provide active cooling

The XBee Cellular Modem can become hot if you use it in the maximum upload or download scenarios, see [Heat considerations](#). One method of heat mitigation is to attach a fan to the device

to provide active cooling.

If you attach a fan, use [P1 \(DIO11/PWM1 Configuration\)](#) to enable this functionality on pin 7. Set **P1** to 1, which turns the fan on when the device gets above 70 °C and the cellular component is running, and off below 65 °C.

Clean shutdown



WARNING! Improper shutdown of the modem may result in the underlying cellular module becoming irrecoverably unresponsive.

Digi strongly recommends performing a clean shutdown procedure on your XBee cellular devices before removing power from the devices. Performing a shutdown allows the module to unregister from the cellular network and safely store operating parameters. Failure to shutdown properly has the potential to result in delays resuming network operation and in some rare instances may result in an unrecoverable module failure.

You can use any of the following methods to perform a clean shutdown.

SD (Shutdown) command

You should use the [SD command](#) to safely shut down a device before removing power. This is the recommended method.

Issue the **SD** command. When the shut down process is complete, the device returns **OK**. After the device responds **OK**, you can safely remove power from the device.

The device will return **ERROR** if any of the following actions are in progress:

- Over-the-air update of the cellular component
- Local update of the cellular component
- Over-the-air update of the XBee firmware.

In addition, if the radio can't be fully shut down within two minutes, the device returns **ERROR**.

You can verify the state of the device using the [AI command](#). After you issue the **SD** command and a response has been returned (either **OK** or **ERROR**), issue the **AI** command. If the shutdown was successful, **2D** is returned.

Custom configuration: Create a new factory default

You can create a custom configuration that is used as a new factory default. This feature is useful if you need, for example, to maintain certain settings for manufacturing or want to ensure a feature is always enabled. When you perform a factory reset on the device using the [RE command](#), the custom configuration is set on the device rather than the original factory default settings.

For example, by default the baud rate is set to 9600. You can create a custom configuration where the baud rate is set to 115200 by default. When you use the **RE** command to reset the device to the factory defaults, the baud rate is set to the custom configuration (115200) rather than the original factory default (9600).

The custom configuration is stored in non-volatile memory. You can continue to create and save custom configurations until the device's memory runs out of space. If there is no space left to save a configuration, XBee returns an error.

You can use the **IC** command to clear or overwrite a custom configuration at any time.

Set a custom configuration

1. Open XBee Studio on the device.
2. [Enter Command mode](#).
3. Perform the following process for each configuration that you want to set as a factory default.
 - a. Issue an **AT%F** command. This command enables you to enter a custom configuration.
 - b. Issue the custom configuration command. For example: **ATBD 7**. This command sets the default for the baud rate to 115200.

Clear all custom configurations on a device

After you have set configurations using the AT%F command, you can return all configurations to the original factory defaults.

1. Open XBee Studio on the device.
2. [Enter Command mode](#).
3. Issue **ATIC**.

SIM cards

- For reliability, use a SIM card with gold-plated contacts. Gold-plated contacts provide protection against oxidation, which can occur over time and with exposure to humidity in the air.
- Vibration in the application environment is the most common cause of SIM card failure, which results in loss of communications with the mobile network.
- The specific failure mode is fretting between the contacts of the SIM card and the card holder. For highest reliability, Digi strongly recommends that you apply a thin layer of dielectric grease to the SIM contacts prior to installing the SIM card. You need only to apply enough dielectric grease that the mating area of the contacts is protected from exposure to air and humidity.

Cellular connection process

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Connecting

In normal operations, the XBee Cellular Modem automatically attempts both a cellular network connection and a data network connection on power-up. The sequence of these connections is as follows:

Cellular network

1. The device powers on.
2. The modem reads the SIM card.
3. It looks for cellular towers.
4. It chooses a candidate tower based on SIM card setting and signal strength.
5. It negotiates a connection.
6. It completes cellular registration; the phone number and SMS are available.

Data network connection

1. The network enables the evolved packet system (EPS) bearer with an access point name (APN). See [AN \(Access Point Name\)](#) if you have APN issues.
2. The device negotiates a data connection with the access point.
3. The device receives its IP configuration and address.
4. The [AI \(Association Indication\)](#) command now returns a 0 and the sockets become available.

Data communication with remote servers (TCP/UDP)

Once the data network connection is established, communication with remote servers can be initiated in several ways.

- Transparent mode data sent to the serial port (see [TD \(Text Delimiter\)](#) and [RO \(Packetization Timeout\)](#) for timing).
- API mode: [Transmit \(TX\) Request: IPv4 - 0x20](#) received over the serial connection.
- [Extended Sockets API frames](#)
- [MicroPython](#)
- Digi Remote Manager connectivity begins.

Data communication begins when:

1. A socket opens to the remote server.
2. Data is sent.

Data connectivity ends when:

1. The server closes the connection.
2. The **TM** timeout expires (see [TM \(IP Client Connection Timeout\)](#)).
3. The cellular network may also close the connection after a timeout set by the network operator.

Disconnecting

When the XBee Cellular Modem is put into Airplane mode, deep sleep is requested, or ATSD (shutdown) command is executed:

1. Sockets are closed, cleanly if possible.
2. The cellular connection is shut down.
3. The cellular component is powered off.

Note We recommend performing a safe shutdown before resetting or rebooting the device to allow the cellular module to detach from the network.

Modes

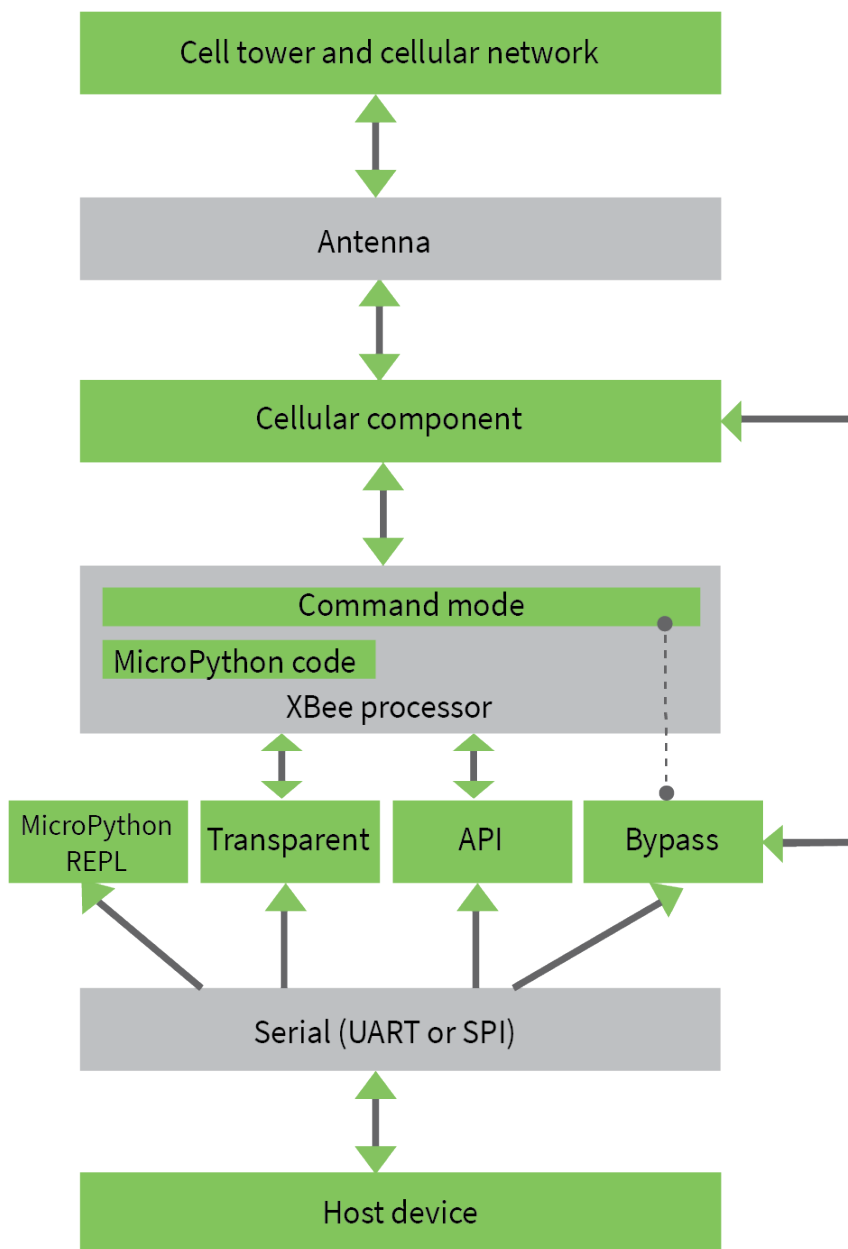
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Select an operating mode

The XBee Cellular Modem interfaces to a host device such as a microcontroller or computer through a logic-level asynchronous serial port. It uses a [UART](#) for serial communication with those devices.

The XBee Cellular Modem supports three operating modes: Transparent operating mode, API operating mode, and Bypass operating mode. The default mode is Transparent operating mode. Use the [AP \(API Enable\)](#) command to select a different operating mode.

The following flowchart illustrates how the modes relate to each other.



Transparent operating mode

Devices operate in this mode by default. The device acts as a serial line replacement when it is in Transparent operating mode. The device queues all serial data it receives through the DIN pin for RF transmission. When a device receives RF data, it sends the data out through the DOUT pin. You can set the configuration parameters using Command mode.

The [IP \(IP Protocol\)](#) command setting controls how Transparent operating mode works for the XBee Cellular Modem.

Note Transparent operation is not available when using SPI.

API operating mode

API operating mode is an alternative to Transparent operating mode. API mode is a frame-based protocol that allows you to direct data on a packet basis. The device communicates UART or SPI data in packets, also known as API frames. This mode allows for structured communications with computers and microcontrollers.

The advantages of API operating mode include:

- It is easier to send information to multiple destinations
- The host receives the source address for each received data frame
- You can change parameters without entering Command mode

Command mode

Command mode is a state in which the firmware interprets incoming characters as commands. It allows you to modify the device's configuration using parameters you can set using AT commands. When you want to read or set any parameter of the XBee Cellular Modem using this mode, you have to send an AT command. Every AT command starts with the letters **AT** followed by the two characters that identify the command and then by some optional configuration values.

The operating modes of the XBee Cellular Modem are controlled by the [AP \(API Enable\)](#) setting, but Command mode is always available as a mode the device can enter while configured for any of the operating modes.

Command mode is available on the UART interface for all operating modes. You cannot use the SPI interface to enter Command mode.

Enter Command mode

To get a device to switch into Command mode, you must issue the following sequence: **+++** within one second. There must be at least one second preceding and following the **+++** sequence. Both the command character (**CC**) and the silence before and after the sequence (**GT**) are configurable. When the entrance criteria are met, the device responds with **OK\r** on UART signifying that it has entered Command mode successfully and is ready to start processing AT commands.

If configured to operate in [Transparent operating mode](#), when entering Command mode the XBee Cellular Modem knows to stop sending data and start accepting commands locally.

Note Do not press **Return** or **Enter** after typing **+++** because it interrupts the guard time silence and prevents you from entering Command mode.

When the device is in Command mode, it listens for user input and is able to receive AT commands on the UART. If **CT** time (default is 10 seconds) passes without any user input, the device drops out

of Command mode and returns to the previous operating mode. You can force the device to leave Command mode by sending [CN \(Exit Command mode\)](#).

You can customize the command character, the guard times and the timeout in the device's configuration settings. For more information, see [CC \(Command Sequence Character\)](#), [CT \(Command Mode Timeout\)](#) and [GT \(Guard Times\)](#).

Troubleshooting

Failure to enter Command mode is often due to baud rate mismatch. Ensure that the baud rate of the connection matches the baud rate of the device. By default, [BD \(Baud Rate\)](#) = 3 (9600 b/s).

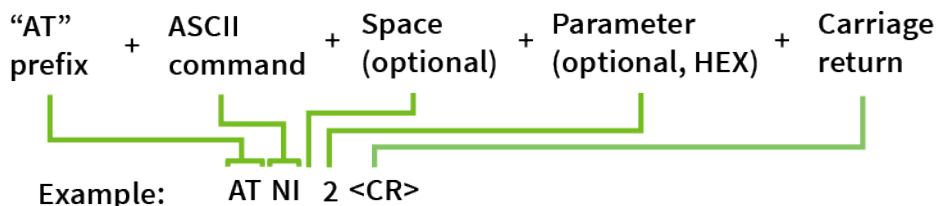
There are two alternative ways to enter Command mode:

- A serial break for six seconds enters Command mode. You can issue the "break" command from a serial console, it is often a button or menu item.
- Asserting DIN (serial break) upon power up or reset enters Command mode. XBee Studio guides you through a reset and automatically issues the break when needed.

Both of these methods temporarily set the device's baud rate to 9600 and return an **OK** on the UART to indicate that Command mode is active. When Command mode exits, the device returns to normal operation at the baud rate that **BD** is set to.

Send AT commands

Use the following diagram to read an AT command:



Once the device enters Command mode, use the syntax in the above figure to send AT commands. Every AT command starts with the letters **AT**, which stands for "attention." The AT is followed by two characters that indicate which command is being issued, then by some optional configuration values.

To read a parameter value stored in the device's register, omit the parameter field.

Multiple AT commands

You can send multiple AT commands at a time when they are separated by a comma in Command mode; for example, **ATNI**My XBee,**AC**<cr>.

The preceding example changes the [NI \(Node Identifier\)](#) to **My XBee** and makes the setting active through [AC \(Apply Changes\)](#).

Parameter format

Refer to the list of [AT commands](#) for the format of individual AT command parameters. Valid formats for hexadecimal values include with or without a leading **0x** for example **FFFF** or **0xFFFF**.

Response to AT commands

When using AT commands to set parameters the XBee Cellular Modem responds with **OK**<cr> if successful and **ERROR**<cr> if not.

For devices with a file system:

ATAP1<cr>

OK<cr>

When reading parameters, the device returns the current parameter value instead of an **OK** message.

ATAP<cr>

1<cr>

Apply command changes

Any changes you make to the configuration command registers using AT commands do not take effect until you apply the changes. For example, if you send the **BD** command to change the baud rate, the actual baud rate does not change until you apply the changes. To apply changes:

1. Send [AC \(Apply Changes\)](#).
2. [Exit Command mode](#).

Make command changes permanent

Send a [WR \(Write\)](#) command to save the changes. **WR** writes parameter values to non-volatile memory so that parameter modifications persist through subsequent resets.

Send a [RE \(Restore Defaults\)](#) to wipe all settings to their factory defaults including those saved using **WR**.

Note You still have to use **WR** to save the changes enacted with **RE**.

Exit Command mode

1. Send [CN \(Exit Command mode\)](#) followed by a carriage return.
or:
2. If the device does not receive any valid AT commands within the time specified by [CT \(Command Mode Timeout\)](#), it returns to Transparent or API mode. The default Command mode timeout is 10 seconds.

For an example of programming the device using AT Commands and descriptions of each configurable parameter, see [AT commands](#).

MicroPython mode

MicroPython mode (**AP** = 4) allows you to communicate with the XBee Cellular Modem using the MicroPython programming language. You can use the MicroPython Terminal tool in XBee Studio to communicate with the MicroPython stack of the XBee Cellular Modem through the serial interface.

MicroPython mode connects the primary serial port to the stdin/stdout interface on MicroPython, which is either the REPL or code launched at startup.

When code runs in MicroPython with **AP** set to a value other than 4, stdout is discarded and there is no input to read on stdin.

Bypass operating mode (DEPRECATED)



WARNING! Bypass mode is now deprecated and is not recommended for new designs. Direct access to the cellular module is not recommended or supported on the XBee Cellular 3G Global model.



CAUTION! Bypass operating mode is an alternative to Transparent and API modes for advanced users with special configuration needs. Changes made in this mode might change or disable the device and we do not recommend it for most users.

In Bypass mode, the device acts as a serial line replacement to the cellular component. In this mode, the XBee Cellular Modem exposes all control of the cellular component's AT port through the UART. If you use this mode, you must setup the cellular modem directly to establish connectivity. The modem does not automatically connect to the network.

Note The cellular component can become unresponsive in Bypass mode. See [Unresponsive cellular component in Bypass mode](#) for help in this situation.

When Bypass mode is active, most of the XBee Cellular Modem's AT commands do not work. For example, **IM** (IMEI) may never return a value, and **DB** does not update. In this configuration, the firmware does not test communication with the cellular component (which it does by sending AT commands). This is useful in case you have reconfigured the cellular component in a way that makes it incompatible with the firmware. Bypass operating mode exists for users who wish to communicate directly with the cellular component settings and do not intend to use XBee Cellular Modem software features such as API mode.

Command mode is available while in Bypass mode; see [Enter Command mode](#) for instructions.

Enter Bypass operating mode

To configure a device for Bypass operating mode:

1. Set the [AP \(API Enable\)](#) parameter value to **5**.
2. Send [WR \(Write\)](#) to write the changes.
3. Send [FR \(Force Reset\)](#) to reboot the device.
4. After rebooting, enter Command mode and verify that Bypass operating mode is active by querying [AI \(Association Indication\)](#) and confirming that it returns a value of **0x2F**.

It may take a moment for Bypass operating mode to become active.

Leave Bypass operating mode

To configure a device to leave Bypass operating mode:

1. Set [AP \(API Enable\)](#) to something other than **5**.
2. Send [WR \(Write\)](#) to write the changes.
3. Send [FR \(Force Reset\)](#) to reboot the device.

4. After rebooting, enter Command mode and verify that Bypass operating mode is not active by querying [AI \(Association Indication\)](#) and confirming that it returns a value other than 0x2F.

Restore cellular settings to default in Bypass operating mode

Send **AT&F0** to reset the cellular component to its factory profile.

Sleep modes

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About sleep modes

A number of low-power modes exist to enable devices to operate for extended periods of time on battery power. Use [SM \(Sleep Mode\)](#) to enable these sleep modes.

Normal mode

Set **SM** to 0 to enter Normal mode.

Normal mode is the default sleep mode. If a device is in this mode, it does not sleep and is always awake.

Devices in Normal mode are typically mains powered.

Pin sleep mode

Set **SM** to 1 to enter pin sleep mode.

Pin sleep allows the device to sleep and wake according to the state of the SLEEP_RQ pin (pin 9).

When you assert SLEEP_RQ (high), the device finishes any transmit or receive operations, closes any active connection, and enters a low-power state.

When you de-assert SLEEP_RQ (low), the device wakes from pin sleep.

Cyclic sleep mode

Set **SM** to 4 to enter Cyclic sleep mode.

Cyclic sleep allows the device to sleep for a specific time and wake for a short time to poll.

If you use the **D7** command to enable hardware flow control, the $\overline{\text{CTS}}$ pin asserts (low) when the device wakes and can receive serial data, and de-asserts (high) when the device sleeps.

Cyclic sleep with pin wake up mode

Set **SM** to 5 to enter Cyclic sleep with pin wake up mode.

This mode is a slight variation on Cyclic sleep mode (**SM** = 4) that allows you to wake a device prematurely by de-asserting the SLEEP_RQ pin (pin 9).

In this mode, you can wake the device after the sleep period expires, or if a high-to-low transition occurs on the SLEEP_RQ pin.

Airplane mode

While not technically a sleep mode, Airplane mode is another way of saving power. When set, the cellular component of the XBee Cellular Modem is fully turned off and no access to the cellular network is performed or possible. Use [AM \(Airplane Mode\)](#) to configure this mode.

Sleep timer

The sleep timer starts when the device wakes and resets on re-configuration. When the sleep timer expires the device returns to sleep.

MicroPython sleep behavior

When the XBee Cellular Modem enters Deep Sleep mode, any MicroPython code currently executing is suspended until the device comes out of sleep. When the XBee Cellular Modem comes out of sleep mode, MicroPython execution continues where it left off.

Upon entering deep sleep mode, the XBee Cellular Modem closes any active TCP/UDP connections and turns off the cellular component. As a result, any sockets that were opened in MicroPython prior to sleep report as no longer being connected. This behavior appears the same as a typical socket disconnection event will:

- **socket.send** raises **OSError: ENOTCONN**
- **socket.sendto** raises **OSError: ENOTCONN**
- **socket.recv** returns the empty string, the traditional end-of-file return value
- **socket.recvfrom** returns an empty message, for example:
(b'', (<address from connect()>, <port from connect()>))
The underlying UDP socket resources have been released at this point.

Serial communication

Serial interface

The XBee Cellular Modem interfaces to a host device through a serial port. The device's serial port can communicate:

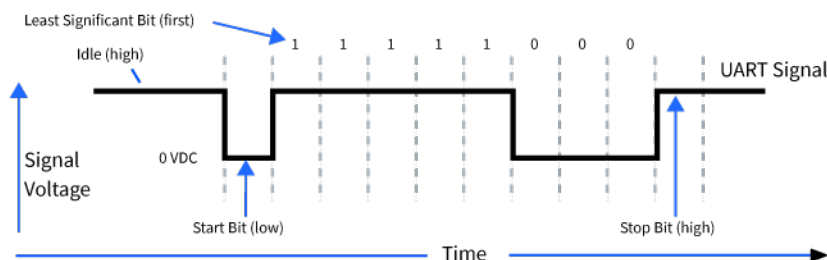
- Through a logic and voltage compatible universal asynchronous receiver/transmitter (UART).
- Through a level translator to any serial device, for example, through an RS-232 or USB interface board.
- Through a serial peripheral interface (SPI) port.

Serial data

A device sends data to the XBee Cellular Modem's UART through pin 3 DIN as an asynchronous serial signal. When the device is not transmitting data, the signals should idle high.

For serial communication to occur, you must configure the UART of both devices (the microcontroller and the XBee Cellular Modem) with compatible settings for the baud rate, parity, start bits, stop bits, and data bits.

Each data byte consists of a start bit (low), 8 data bits (least significant bit first) and a stop bit (high). The following diagram illustrates the serial bit pattern of data passing through the device. The diagram shows UART data packet 0x1F (decimal number 31) as transmitted through the device.

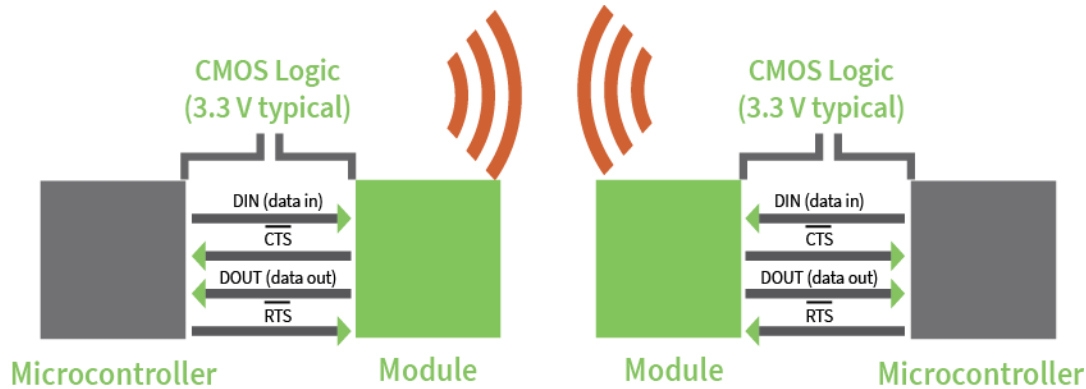


You can configure the UART baud rate, parity, and stop bits settings on the device with the **BD**, **NB**, and **SB** commands respectively. For more information, see [Serial interfacing commands](#).

In the rare case that a device has been configured with the UART disabled, you can recover the device to UART operation by holding DIN low at reset time. DIN forces a default configuration on the UART at 9600 baud and it brings the device up in Command mode on the UART port. You can then send the appropriate commands to the device to configure it for UART operation. If those parameters are written, the device comes up with the UART enabled on the next reset.

UART data flow

Devices that have a UART interface connect directly to the pins of the XBee Cellular Modem as shown in the following figure. The figure shows system data flow in a UART-interfaced environment. Low-asserted signals have a horizontal line over the signal name.



Serial buffers

The XBee Cellular Modem maintains internal buffers to collect serial and RF data that it receives. The serial receive buffer collects incoming serial characters and holds them until the device can process them. The serial transmit buffer collects the data it receives via the RF link until it transmits that data out the serial or SPI port.

Flow control (output)

We strongly encourage you to use flow control with the XBee Cellular Modem to prevent buffer overruns.

Flow control (output) is enabled by default; you can disable it with [D7 \(DIO7/CTS\)](#). When the serial receive buffer fills with the number of bytes specified by [FT \(Flow Control Threshold\)](#), the device de-asserts $\overline{\text{CTS}}$ (sets it high) to signal the host device to stop sending serial data. The device re-asserts $\overline{\text{CTS}}$ when less than FT-16 bytes are in the UART receive buffer.

Note Serial flow control is not possible when using the SPI port.

Flow control (input)

If you set [D6 \(DIO6/RTS\)](#) to enable flow control (input), the device does not send data in the serial transmit buffer out the DOUT pin as long as RTS is de-asserted (set high). Do not de-assert RTS for long periods of time or the serial transmit buffer will fill.

SPI operation

SPI communications

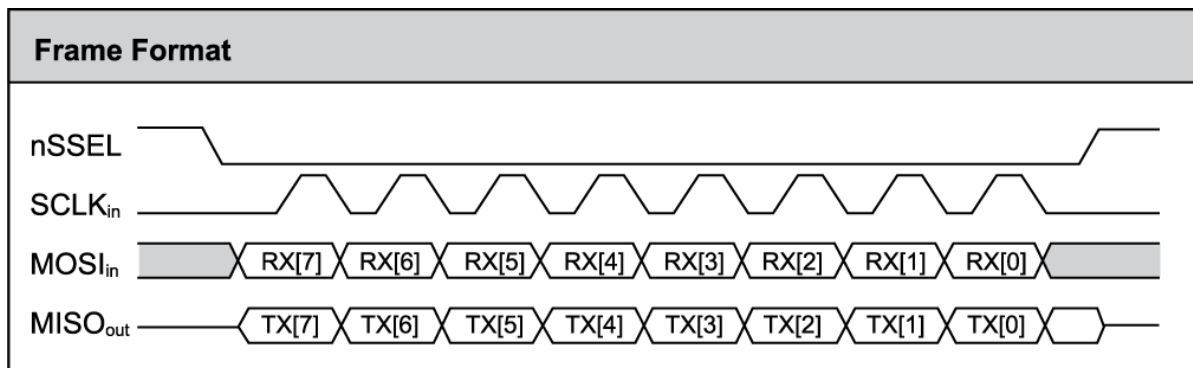
The XBee Cellular Modem supports SPI communications in slave mode. Slave mode receives the clock signal and data from the master and returns data to the master. The following table shows the signals that the SPI port uses on the device.

Signal	Function
SPI_MOSI (Master Out, Slave In)	Inputs serial data from the master
SPI_MISO (Master In, Slave Out)	Outputs serial data to the master
SPI_SCLK (Serial Clock)	Clocks data transfers on MOSI and MISO
SPI_SSEL (Slave Select)	Enables serial communication with the slave
SPI_ATTN (Attention)	Alerts the master that slave has data queued to send. The XBee Cellular Modem asserts this pin as soon as data is available to send to the SPI master and it remains asserted until the SPI master has clocked out all available data.

In this mode:

- SPI clock rates up to 6 MHz are possible.
- Data is most significant bit (MSB) first; bit 7 is the first bit of a byte sent over the interface.
- Frame Format mode 0 is used. This means CPOL= 0 (idle clock is low) and CPHA = 0 (data is sampled on the clock's leading edge).
- The SPI port only supports API Mode (**AP = 1**).

The following diagram shows the frame format mode 0 for SPI communications.



SPI mode is chip to chip communication. We do not supply a SPI communication option on the device development evaluation boards.

Full duplex operation

The specification for SPI includes the four signals SPI_MISO, SPI_MOSI, SPI_CLK, and SPI_SSEL. Using these four signals, the SPI master cannot know when the slave needs to send and the SPI slave cannot transmit unless enabled by the master. For this reason, the SPI_ATTN signal is available in the design. This allows the SPI slave to alert the SPI master that it has data to send. In turn, the SPI master is expected to assert SPI_SSEL and start SPI_CLK, unless these signals are already asserted and active respectively. This, in turn, allows the XBee Cellular Modem SPI slave to send data to the master.

SPI data is latched by the master and slave using the SPI_CLK signal. When data is being transferred the MISO and MOSI signals change between each clock. If data is not available then these signals will not change and will be either 0 or 1. This results in receiving either a repetitive 0 or 0xFF. The means of determining whether or not received data is valid is by packetizing the data with API packets, without escaping. Valid data to and from the XBee Cellular Modem is delimited by 0x7E, a length, the payload, and finally a checksum byte. Everything else in both directions should be ignored. The bytes received between frames will be either 0xFF or 0x00. This allows the SPI master to scan for a 0x7E delimiter between frames.

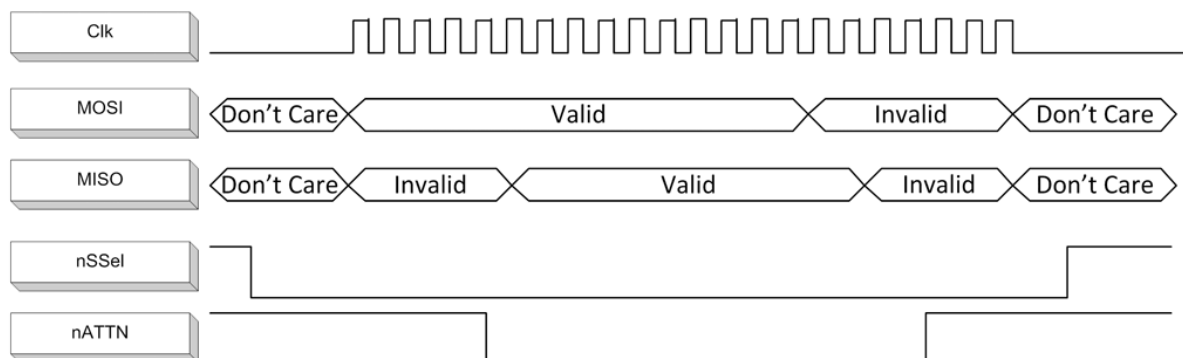
SPI allows for valid data from the slave to begin before, at the same time, or after valid data begins from the master. When the master is sending data to the slave and the slave has valid data to send in the middle of receiving data from the master, it allows a true full duplex operation where data is valid in both directions for a period of time. During this time, the master and slave must simultaneously transmit valid data at the clock speed so that no invalid bytes appear within an API frame, causing the whole frame to be discarded.

An example follows to more fully illustrate the SPI interface during the time valid data is being sent in both directions. First, the master asserts SPI_SSEL and starts SPI_CLK to send a frame to the slave.

Initially, the slave does not have valid data to send the master. However, while it is still receiving data from the master, it has its own data to send. Therefore, it asserts SPI_ATTN low. Seeing that SPI_SSEL is already asserted and that SPI_CLK is active, it immediately begins sending valid data, even while it is receiving valid data from the master. In this example, the master finishes its valid data before the slave does. The master will have two indications of valid data: The SPI_ATTN line is asserted and the API frame length is not yet expired. For both of these reasons, the master should keep SPI_SSEL asserted and should keep SPI_CLK toggling in order to receive the end of the frame from the slave, even though these signals were originally turned on by the master to send data. During the time that the SPI master is sending invalid data to the SPI slave, it is important no

0x7E is included in that invalid data because that would trigger the SPI slave to start receiving another valid frame.

The following figure illustrates the SPI interface while valid data is being sent in both directions.



Low power operation

Sleep modes generally work the same on SPI as they do on UART. However, due to the addition of SPI mode, there is an option of another sleep pin, as described below.

By default, Digi configures DIO8 (SLEEP_REQUEST) as a peripheral and during pin sleep it wakes the device and puts it to sleep. This applies to both the UART and SPI serial interfaces.

If SLEEP_REQUEST is not configured as a peripheral and SPI_SSEL is configured as a peripheral, then pin sleep is controlled by SPI_SSEL rather than by SLEEP_REQUEST. Asserting SPI_SSEL (pin 17) by driving it low either wakes the device or keeps it awake. Negating SPI_SSEL by driving it high puts the device to sleep.

Using SPI_SSEL to control sleep and to indicate that the SPI master has selected a particular slave device has the advantage of requiring one less physical pin connection to implement pin sleep on SPI. It has the disadvantage of putting the device to sleep whenever the SPI master negates SPI_SSEL (meaning time is lost waiting for the device to wake), even if that was not the intent.

If the user has full control of SPI_SSEL so that it can control pin sleep, whether or not data needs to be transmitted, then sharing the pin may be a good option in order to make the SLEEP_REQUEST pin available for another purpose.

If the device is one of multiple slaves on the SPI, then the device sleeps while the SPI master talks to the other slave, but this is acceptable in most cases.

If you do not configure either pin as a peripheral, then the device stays awake, being unable to sleep in SM1 mode.

Select the SPI port

To force SPI mode, hold DOUT/DIO13 pin 2 low while resetting the device until SPI_ATTEN asserts. This causes the device to disable the UART and go straight into SPI communication mode. Once configuration is complete, the device queues a modem status frame to the SPI port, which causes the SPI_ATTEN line to assert. The host can use this to determine that the SPI port is configured properly. This method forces the configuration to provide full SPI support for the following parameters:

- **D1 (DIO1/AD1)** (This parameter will only be changed if it is at a default of zero when the method is invoked.)
- **D2 (DIO2/AD2)**
- **D3 (DIO3/AD3)**
- **D4 (DIO4)**
- **P2 (DIO12 Configuration)**

As long as the host does not issue a **WR (Write)** command, these configuration values revert to previous values after a power-on reset. If the host issues a **WR** command while in SPI mode, these same parameters are written to flash. After a reset, parameters that were forced and then written to flash become the mode of operation.

If the UART is disabled and the SPI is enabled in the written configuration, then the device comes up in SPI mode without forcing it by holding DOUT low. If both the UART and the SPI are enabled at the time of reset, then output goes to the UART until the host sends the first input. If that first input comes on the SPI port, then all subsequent output goes to the SPI port and the UART is disabled. If the first input comes on the UART, then all subsequent output goes to the UART and the SPI is disabled.

Once you select a serial port (UART or SPI), all subsequent output goes to that port, even if you apply a new configuration. The only way to switch the selected serial port is to reset the device. On surface-mount devices, forcing DOUT low at the time of reset has no effect. To use SPI mode on the SMT devices, assert the SPI_SSEL (pin 17) low after reset and before any UART data is input.

When the master asserts the slave select (SPI_SSEL) signal, SPI transmit data is driven to the output pin SPI_MISO, and SPI data is received from the input pin SPI_MOSI. The SPI_SSEL pin has to be asserted to enable the transmit serializer to drive data to the output signal SPI_MISO. A rising edge on SPI_SSEL causes the SPI_MISO line to be tri-stated such that another slave device can drive it, if so desired.

If the output buffer is empty, the SPI serializer transmits the last valid bit repeatedly, which may be either high or low. Otherwise, the device formats all output in API mode 1 format, as described in [Operate in API mode](#). The attached host is expected to ignore all data that is not part of a formatted API frame.

Force UART operation

If you configure a device with only the SPI enabled and no SPI master is available to access the SPI slave port, you can recover the device to UART operation by holding DIN / CONFIG low at reset time. DIN/CONFIG forces a default configuration on the UART at 9600 baud and brings up the device in Command mode on the UART port. You can then send the appropriate commands to the device to configure it for UART operation. If you write those parameters, the device comes up with the UART enabled on the next reset.

Data format

SPI only operates in API mode 1. The XBee Cellular Modem does not support Transparent mode or API mode 2 (which escapes control characters). This means that the AP configuration only applies to the UART, and the device ignores it while using SPI. The reason for this operation choice is that SPI is full duplex. If data flows in one direction, it flows in the other. Since it is not always possible to have valid data flowing in both directions at the same time, the receiver must have a way to parse out the valid data and to ignore the invalid data.

The XBee Cellular Modem sends **0xFF** when there is no data to send to the host.

File system

For detailed information about using MicroPython on the XBee Cellular Modem refer to the [Digi MicroPython Programming Guide](#).

Overview of the file system

XBee Cellular Modem firmware versions ending in **0B** (for example, 1130B, 100B, 3100B) and later include support for storing files on an internal 1 MB SPI flash.



CAUTION! You need to [format the file system](#) if upgrading a device that originally shipped with older firmware. You can use XBee Studio, AT commands, or MicroPython for that initial format or to erase existing content at any time.

See [ATFS FORMAT confirm](#) and ensure that the format is complete.

Directory structure

The SPI flash appears in the file system as **/flash**, the only entry at the root level of the file system. It has a **lib** directory intended for MicroPython modules and a **cert** directory for files used for TLS sockets.

Paths

The XBee Cellular Modem stores all of its files in the top-level directory **/flash**. On startup, the **ATFS** commands and MicroPython each use that as their current working directory. When specifying the path to a file or directory, it is interpreted as follows:

- Paths starting with a forward slash are "absolute" and must start with **/flash** to be valid.
- All other paths are relative to the current working directory.
- The directory **..** refers to the parent directory, so an operation on **../filename.txt** that takes place in the directory **/flash/test** accesses the file **/flash/filename.txt**.
- The directory **.** refers to the current directory, so the command **ATFS ls .** lists files in the current directory.
- Names are case-insensitive, so **FILE.TXT**, **file.txt** and **FiLe.TxT** all refer to the same file.
- File and directory names are limited to 64 characters, and can only contain letters, numbers, periods, dashes and underscores. A period at the end of the name is ignored.
- The full, absolute path to a file or directory is limited to 255 characters.

Secure files

The file system includes support for secure files with the following properties:

- Created via the **ATFS XPUT** command or in MicroPython using a mode of *** with the `open()` method.**
- Unable to download via the **ATFS GET** command or MicroPython's **`open()` method.**
- SHA256 hash of file contents available from **ATFS HASH** command (to compare with a local copy of a file).
- Encrypted on the SPI flash.
- MicroPython can execute code in secure files.
- Sockets can use secure files when creating TLS connections.

Encrypt files

You can encrypt files on the file system. This provides two things:

1. Protection of the client private key for TLS authentication while it is stored on the XBee Cellular Modem.
2. Protection for user's MicroPython applications.

Use **ATFS XPUT filename** to place encrypted files on the file system. The XPUT operation is otherwise identical to the PUT operation. Files placed in this way are indicated with a **pound sign (#)** following the filename. The XBee Cellular Modem does not allow an encrypted file to be read by normal use so it:

1. Cannot be retrieved with the GET operation.
2. Cannot be opened and read in MicroPython applications.
3. Cannot be created by a MicroPython application.

When **ATFS HASH filename** is run with the filename of an encrypted file, it reports the SHA256 hash of the file contents. In this way you can validate that the correct file has been placed on the XBee Cellular Modem.

SMS behaviors

SMS encoding

The XBee Cellular Modem transmits SMS messages using the standard [GSM 03.38](#) character set.¹ Because this character set only provides 7 bits of space per character, the XBee Cellular Modem ignores the most significant bit of each octet in an SMS transmission payload.

The device converts incoming SMS messages to ASCII. Characters that cannot be represented in ASCII are replaced with a space (' ', or 0x20 in hex). This includes emoji and other special characters.

¹Also referred to as the GSM 7-bit alphabet.

Socket behavior

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Supported sockets

The XBee Cellular Modem supports the following number of sockets:

- 7 maximum: some combination of 4 TCP, 4 UDP, 4 TLS.¹

Best practices when using sockets

Sockets and Remote Manager

If you use Remote Manager to remotely communicate with and configure your XBee Cellular device, you must leave at least two sockets available in the system: one UDP socket (for periodic low-data-usage check-ins), and one TCP/TLS socket (to be used when a full connection is needed).

If your application allocates so many sockets that Remote Manager functionality in the firmware cannot get the sockets that it requires, Remote Manager functionality will be prevented from working until sockets become available.

For example, each call to `socket.socket()` in MicroPython will allocate a socket, and this socket will remain allocated to MicroPython until the socket's close method is called, or the MicroPython REPL is restarted using Ctrl-D.

See [Supported sockets](#) for more information on the total number of sockets supported by the device.

Sockets and API mode

When using API mode to transmit TCP/TLS data to a remote destination (using the [Transmit \(TX\) Request: IPv4 - 0x20](#) or [Tx Request with TLS Profile - 0x23](#) frames), sending a large amount of data as a single API frame is preferable to multiple smaller API frames. Using a single large API frame allows the XBee to transmit the data using fewer operations than transmitting multiple pieces of data in sequence, which improves overall throughput.

Additionally, one API frame consumes less dynamic memory in the system than multiple smaller API frames, which means there will be more memory available to process incoming IP data as well as subsequent API frames sent into the XBee Cellular device.

Socket timeouts

The XBee Cellular Modem implicitly opens the socket any time there is data to be sent, and closes it according to the timeout settings. The [TM \(IP Client Connection Timeout\)](#) command controls the timeout settings.

Socket limits in API mode

In API mode there are a fixed number of sockets available; see [Supported sockets](#). When a [Transmit \(TX\) Request: IPv4 - 0x20](#) frame is sent to the XBee Smart Modem for a new destination, it creates a new socket. The exception to this is when using the UDP protocol with the C0 source port, which allows unlimited destinations on the socket created by [C0 \(Source Port\)](#). If no more sockets are available, the device sends back a [Transmit \(TX\) Status - 0x89](#) frame with a Resource Error. The Resource Error resolves when an existing socket is closed. An existing socket may be

¹1 UDP socket is always reserved for DNS, so subtract 1 socket from the values above.

closed when the socket times out (see [TM \(IP Client Connection Timeout\)](#) and [TS \(IP Server Connection Timeout\)](#)) or when the socket is closed via a TX request with the CLOSE flag set.

In API mode each socket has a maximum number of pending Transmit (TX) Requests allowed. When a [Transmit \(TX\) Request: IPv4 - 0x20](#) frame is sent to the XBee Smart Modem for an existing destination, it sends that request using the socket for that destination. If the number of pending Transmit (TX) Requests would be exceeded for the socket, the device sends back a [Transmit \(TX\) Status - 0x89](#) frame with a Resource Error indicating that the device is not able to send the request and should retry again later. The Resource Error resolves when a Transmit (TX) Request that is pending on the socket is transmitted; this is indicated by the Transmit (TX) Status frame for the request.

UDP datagram size limits

The maximum supported size for UDP datagrams either transmitted from or received by the XBee is as follows:

	Max supported size
Transmitted from	1024
Received by	1024

Enable incoming TCP connections

TCP establishes virtual connections between the XBee Cellular Modem and other devices. You can enable the XBee Cellular Modem to listen for incoming TCP connections. Listen means waiting for a connection request from any remote TCP and port.

The XBee Cellular Modem only supports incoming TCP and UDP connections as configured in [IP \(IP Protocol\)](#), TLS is not supported.

Enable incoming connections in XBee Studio

1. Set [AP \(API Enable\)](#) to **Transparent Mode [0]** or **API Mode**. You can use either API mode with escapes or without escapes.
2. Set **IP** to **TCP [1]** or **UDP [0]**.
3. Set **C0 (Source Port)** to the value of the TCP port that the device listens on.
4. Click the **Write** button .

Enable incoming connections in MicroPython

When you enable incoming connections in MicroPython (set [AP \(API Enable\)](#) to **MicroPython REPL [4]**), note that the port and protocol are specified in the MicroPython code. No extra steps are needed.

API mode behavior for outgoing TCP and TLS connections

To initiate an outgoing TCP or TLS connection to a remote host, send a [Transmit \(TX\) Request: IPv4 - 0x20](#) frame to the XBee Cellular Modem's serial port specifying the destination address and destination port for the remote host; the data is optional and the source port is 0.

If the connection is disconnected at any time, send a Transmit TX Request frame to trigger a new connection attempt.

To send data over this connection use the [Transmit \(TX\) Request: IPv4 - 0x20](#).

The device sends a [Transmit \(TX\) Status - 0x89](#) frame in reply to the Transmit TX Request indicating the status of the request. A status of 0 indicates the connection and/or data was successful, a value of 0x32 indicates a temporary Resource Error (see [Socket limits in API mode](#)), and other values indicates a failure.

Any data received on the connection is sent out the XBee Cellular Modem's serial port as a Receive RX frame.

A connection is closed when:

- The remote end closes the connection.
- No data is sent or received for longer than the socket timeout set by [TM \(IP Client Connection Timeout\)](#).
- A Transmit TX Request is sent with the CLOSE flag set.

API mode behavior for outgoing UDP data

To send a UDP datagram to a remote host, send a [Transmit \(TX\) Request: IPv4 - 0x20](#) frame to the XBee Cellular Modem's serial port specifying the destination address and destination port of the remote host. If you use a source port of 0, the device creates a new socket for the purpose of sending to the remote host. The XBee Cellular Modem supports a finite number of sockets, so if you need to send to many destinations:

1. The socket must be closed after use.

or

2. You must use the socket specified by the [C0 \(Source Port\)](#) setting.

To use the socket specified by the **C0** setting, in the Transmit TX request frame use a source port that matches the value configured for the **C0** setting.

The device sends a [Transmit \(TX\) Status - 0x89](#) frame in reply to the Transmit TX Request to indicate the status of the request. A status of 0 indicates the connection and/or data was successful, a value of 0x32 indicates a temporary Resource Error (see [Socket limits in API mode](#)), and other values indicates a failure.

Any data received on the UDP socket is sent out the XBee Cellular Modem's serial port as a [Receive \(RX\) Packet: IPv4 - 0xB0](#) frame.

Outgoing UDP transmissions are limited to 1024 byte payloads. Attempting to send over 1024 bytes results in a TX Status frame with Error type **0x74 (Message too long)**.

A UDP socket is closed when:

- No data has been sent or received for longer than the socket timeout set by [TM \(IP Client Connection Timeout\)](#).
- A transmit TX Request is sent with the CLOSE flag set.

API mode behavior for incoming TCP connections

For incoming connections and data in API mode, the XBee Cellular Modem uses the [C0 \(Source Port\)](#) and [IP \(IP Protocol\)](#) settings to specify the listening port and protocol used. The XBee Cellular Modem does not currently support the TLS protocol for incoming connections.

When the **IP** setting is TCP the XBee Cellular Modem allows multiple incoming TCP connections on the port specified by the **C0** setting. Any data received on the connection is sent out the XBee Cellular Modem's serial port as a **Receive (RX) Packet: IPv4 - 0xB0** frame.

To send data from the device over the connection, use the **Transmit (TX) Request: IPv4 - 0x20** frame with the corresponding address fields received from the Receive RX frame. In other words:

- Take the source address, source port, and destination port fields from the Receive (RX) frame and use those respectively as:
- The destination address, destination port, and source port fields for the Transmit (TX) Request frame.

A connection is closed when:

- The remote end closes the connection.
- No data has been sent or received for longer than the socket timeout set by **TS (IP Server Connection Timeout)**.
- A Transmit (TX) Request frame is sent with the CLOSE flag set.

API mode behavior for incoming UDP data

When the **IP (IP Protocol)** setting is UDP, any data sent from a remote host to the XBee Cellular Modem's network port specified by the **C0 (Source Port)** setting is sent out the XBee Cellular Modem's serial port as a **Receive (RX) Packet: IPv4 - 0xB0** frame.

To send data from the XBee Cellular Modem to the remote destination, use the **Transmit (TX) Request: IPv4 - 0x20** frame with the corresponding address fields received from the Receive RX frame. In other words take the source address, source port, and destination port fields from the Receive (RX) frame and use those respectively as the destination address, destination port, and source port fields for the Transmit (TX) Request frame.

Incoming UDP transmissions over 1024 bytes in length are output in multiple API frames. For example, if a 1500 byte UDP transmission is received first, a frame with a 1024 byte payload is sent out then another frame with a payload of 476 bytes is output.

Transparent mode behavior for outgoing TCP and TLS connections

For Transparent mode, the **IP (IP Protocol)** setting specifies the protocol and the **DL (Destination Address)** and **DE (Destination port)** settings specify the destination address used for outgoing data (UDP) and outgoing connections (TCP and TLS).

To initiate an outgoing TCP or TLS connection to a remote host, send data to the XBee Cellular Modem's serial port. If **CI (Protocol/Connection Indication)** reports a value of **0**, then the connection was successfully established, otherwise the value of **CI** indicates why the connection attempt failed. Any data received over the connection is sent out the XBee Cellular Modem's serial port.

A connection is closed when:

- The remote end closes the connection.
- No data has been sent or received for longer than the socket timeout set by **TM (IP Client Connection Timeout)**.
- You make and apply a change to the **IP**, **DL**, or **DE**.

Transparent mode behavior for outgoing UDP data

To send outgoing UDP data to a remote host, send data to the XBee Cellular Modem's serial port. If [CI \(Protocol/Connection Indication\)](#) reports a value of 0, the data was successfully sent; otherwise, the value of CI indicates why the data failed to be sent.

The [RO \(Packetization Timeout\)](#) setting provides some control in how the serial data gets packetized before being sent to the remote host. The first send opens up a UDP socket used to send and receive data. Any data received by this socket is sent out the XBee Cellular Modem's serial port.

Note Set RO to FF for realtime typing by humans. Also, see [TD \(Text Delimiter\)](#).

Transparent mode behavior for incoming TCP connections

The [C0 \(Source Port\)](#) and [IP \(IP Protocol\)](#) settings specify the listening port and protocol used for incoming connections (TCP) and incoming data (UDP) in Transparent mode. TLS is not currently supported for incoming connections.

When the [IP](#) setting is TCP and there is no existing connection to or from the XBee Cellular Modem, the device accepts one incoming connection. Any data received on the connection is sent out the XBee Cellular Modem's serial port. Any data sent to the XBee Cellular Modem's serial port is sent over the connection. If the connection is disconnected, it discards pending data.

Transparent mode behavior for incoming UDP connections

When the [IP \(IP Protocol\)](#) setting is UDP any data sent from a remote host to the XBee Cellular Modem's network port specified by [C0 \(Source Port\)](#) is sent out the XBee Cellular Modem's serial port. Any data sent to the XBee Cellular Modem's serial port is sent to the network destination specified by the [DL \(Destination Address\)](#) and [DE \(Destination port\)](#) settings. If the [DL](#) and [DE](#) settings are unspecified or invalid, the XBee Cellular Modem discards data sent to the serial port.

Extended Socket frames

The XBee Cellular product line includes a set of Extended Socket frames. You can use these frames in applications where the existing frames ([Transmit Request \(0x20\)](#), [TLS Transmit \(0x23\)](#) and [Receive \(0xB0\)](#)) limit the possibilities for an application.

You can use Extended Socket frames to do the following:

- Multiple simultaneous connections can be made to the same port on the same host. For example, you can overlap simultaneous HTTP requests.
- Immediate unsolicited notification of changes in socket status. This allows an application to react to a server-side socket closure rather than relying on an implicit connection to be re-established for continuing communication.
- A generalized mechanism for per-socket option selection. Currently used for TLS profile selection. Previously this required a unique frame, as options are added, this allows combinations of choices.
- Allow DNS look up during the connection process rather than a separate step.

In addition, for diagnostic purposes, you can use the [Socket Info \(SI\)](#) AT command to retrieve information regarding all open sockets currently active in the system. This can be queried during development or used by an application to confirm or refresh information during execution.

Note Sockets opened with the Extended Socket frames cannot be used with the legacy frames ([Transmit Request \(0x20\)](#), [TLS Transmit \(0x23\)](#) and [Receive \(0xB0\)](#)), nor vice versa.

For a list of the socket frames, see [Available Extended Socket frames](#).

Examples

In the examples below the Frame IDs in all frames are set to 1 for simplicity. Socket IDs in all frames after the Socket Create are hard-coded to 0 as well. If you wish to use the example repeatedly the XBee should be rebooted between attempts.

We recommend the use of the XBee Studio frame generator for experimentation with frames during development. Paste the provided frame content directly into the **Add API frame to list** window in XBee Studio to follow along manually.

[Extended Socket example: Single HTTP Connection](#)

[Extended Socket example: UDP](#)

[Extended Socket example: TCP Listener](#)

Available Extended Socket frames

Note For information about all frames, see [API frames](#).

[Socket Create - 0x40](#)
[Socket Option Request - 0x41](#)
[Socket Connect - 0x42](#)
[Socket Close - 0x43](#)
[Socket Send \(Transmit\) - 0x44](#)
[Socket SendTo \(Transmit Explicit Data\): IPv4 - 0x45](#)
[Socket Bind/Listen - 0x46](#)
[Socket Create Response - 0xC0](#)
[Socket Option Response - 0xC1](#)
[Socket Connect Response - 0xC2](#)
[Socket Close Response - 0xC3](#)
[Socket Listen Response - 0xC6](#)
[Socket New IPv4 Client - 0xCC](#)
[Socket Receive - 0xCD](#)
[Socket Receive From: IPv4 - 0xCE](#)
[Socket Status - 0xCF](#)

Extended Socket example: Single HTTP Connection

This example demonstrates a complete request with an HTTP server. It fetches a random fact about a number from a web services API offered by the website <http://numbersapi.com>.

Note Digi is not affiliated with numbersapi.com and the example is for education only.

Send a Socket Create frame

Note To adapt this example for an HTTPS server, change **Protocol** below to 0x04 (TLS) and optionally use the [Socket Option](#) frame to specify a TLS profile.

Field	Value
Frame type	0x40 (Socket Create)
Frame ID	0x01
Protocol	0x01 (TCP)

Socket Create frame data:

```
7E 00 03 40 01 01 BD
```

Receive a Socket Create response

The XBee responds to the Socket Create request with a response. The response contains the socket ID assigned. In this example, the socket ID is 0.

Field	Value
Frame type	0xC0 (Socket Create Response)
Frame ID	0x01
Socket ID	0x00
Status	0x00 (Success)

Socket Create Response received from XBee:

```
7E 00 04 C0 01 00 00 3E
```

Send Socket Connect

This examples uses the "string" destination address type to have the XBee perform DNS look-up during the connection process.

Note To adapt this example for TLS, use destination port 0x01 0xbb (decimal 443). Be aware that many HTTPS servers use SNI (Server Name Identification) which is not currently supported.

Field	Value
Frame type	0x42 (Socket Create Response)
Frame ID	0x01
Socket ID	0x00
Destination Port	0x00 0x50 (80 decimal, HTTP)
Destination Address Type	0x01 (String)
Destination Address	numbersapi.com

Socket Connect frame data:

```
7E 00 14 42 01 00 00 50 01 6E 75 6D 62 65 72 73 61 70 69 2E 63 6F 6D C8
```

Receive a Socket Connect Response

The request to connect is immediately acknowledged with a response. However, it is not permitted to proceed transmitting data until the next stage, after a Socket Status frame has been received indicating success.

Field	Value
Frame type	0xC2 (Socket Connect Response)
Frame ID	0x01
Socket ID	0x00
Status	0x00 (Success)

Socket Connect Response received from XBee:

```
7E 00 04 C2 01 00 00 3C
```

Receive a Socket Status

The socket has been fully established when a Socket Status frame is received with the connected status after the socket has connected.

Field	Value
Frame type	0xCF (Socket Status)
Socket ID	0x00
Status	0x00 (Connected)

Socket Status received from XBee with connected status:

```
7E 00 03 CF 00 00 30
```

Send HTTP Request using Socket Send frame

The request uses the "Connection: close" header to have the server close the connection on request completion. This allows the example to demonstrate the Socket Status reporting of a close by the peer.

Field	Value
Frame type	0x44 (Socket Status)
Frame ID	0x01
Socket ID	0x00
Transmit Options	0x00
Data	GET /random/trivia HTTP/1.1 Host: numbersapi.com Connection: close

Socket Send frame data:

```
7E 00 4C 44 01 00 00 47 45 54 20 2F 72 61 6E 64 6F 6D 2F 74 72 69 76 69 61 20 48 54 54 50 2F 31 2E 31
0D 0A 48 6F 73 74 3A 20 6E 75 6D 62 65 72 73 61 70 69 2E 63 6F 6D 0D 0A 43 6F 6E 6E 65 63 74 69 6F 6E
3A 20 63 6C 6F 73 65 0D 0A 0D 0A B6
```

Receive TX Status

Extended sockets use the existing TX Status frame (0x89) to report acceptance of the data for transmit.

Field	Value
Frame type	0x89 (TX Status)
Frame ID	0x01
Status	0x00 (Success)

TX Status received from XBee data:

```
7E 00 03 89 01 00 75
```

Receive one or more Receive Data frames

The server will respond with an interesting fact about a number. The following information is a sample response. Multiple frames may be needed to contain the full response content depending on size and network conditions.

Field	Value
Frame type	0xCD (Socket Receive)
Frame ID	0x00
Socket ID	0x00
Status	0x00
Payload	HTTP/1.1 200 OK Server: nginx/1.4.6 (Ubuntu) Date: Thu, 18 Jul 2019 16:13:47 GMT Content-Type: text/plain; charset="UTF-8"; charset=utf-8 Content-Length: 53 Connection: close X-Powered-By: Express Access-Control-Allow-Origin: * Access-Control-Allow-Headers: X-Requested-With X-Numbers-API-Number: 270 X-Numbers-API-Type: trivia Pragma: no-cache Cache-Control: no-cache Expires: 0 270 is the average number of days in human pregnancy.

Receive Data received from XBee containing web service response:

```

7E 01 C5 CD 00 00 00 48 54 54 50 2F 31 2E 31 20 32 30 30 20 4F 4B 0D 0A 53 65 72 76 65 72 3A 20 6E 67
69 6E 78 2F 31 2E 34 2E 36 20 28 55 62 75 6E 74 75 29 0D 0A 44 61 74 65 3A 20 54 68 75 2C 20 31 38 20
4A 75 6C 20 32 30 31 39 20 31 36 3A 31 33 3A 34 37 20 47 4D 54 0D 0A 43 6F 6E 74 65 6E 74 2D 54 79 70
65 3A 20 74 65 78 74 2F 70 6C 61 69 6E 3B 20 63 68 61 72 73 65 74 3D 22 55 54 46 2D 38 22 3B 20 63 68
61 72 73 65 74 3D 75 74 66 2D 38 0D 0A 43 6F 6E 74 65 6E 74 2D 4C 65 6E 67 74 68 3A 20 35 33 0D 0A 43
6F 6E 6E 65 63 74 69 6F 6E 3A 20 63 6C 6F 73 65 0D 0A 58 2D 50 6F 77 65 72 65 64 2D 42 79 3A 20 45 78
70 72 65 73 73 0D 0A 41 63 63 65 73 73 2D 43 6F 6E 74 72 6F 6C 2D 41 6C 6C 6F 77 2D 4F 72 69 67 69 6E
3A 20 2A 0D 0A 41 63 63 65 73 73 2D 43 6F 6E 74 72 6F 6C 2D 41 6C 6C 6F 77 2D 48 65 61 64 65 72 73 3A
20 58 2D 52 65 71 75 65 73 74 65 64 2D 57 69 74 68 0D 0A 58 2D 4E 75 6D 62 65 72 73 2D 41 50 49 2D 4E
75 6D 62 65 72 3A 20 32 37 30 0D 0A 58 2D 4E 75 6D 62 65 72 73 2D 41 50 49 2D 54 79 70 65 3A 20 74 72
69 76 69 61 0D 0A 50 72 61 67 6D 61 3A 20 6E 6F 2D 63 61 63 68 65 0D 0A 43 61 63 68 65 2D 43 6F 6E 74
72 6F 6C 3A 20 6E 6F 2D 63 61 63 68 65 0D 0A 45 78 70 69 72 65 73 3A 20 30 0D 0A 0D 0A 32 37 30 20 69
73 20 74 68 65 20 61 76 65 72 61 67 65 20 6E 75 6D 62 65 72 20 6F 66 20 64 61 79 73 20 69 6E 20 68 75 6D
61 6E 20 70 72 65 67 6E 61 6E 63 79 2E 8B

```

Receive Socket Status indicating closed connection

Finally, due to the "Connection" header in the request, the server should remotely close the connection.

Field	Value
Frame type	0xCF (TX Status)
Socket ID	0x00
Status	0x07 (Connection lost)

Example Socket Status received from XBee indicating connection lost:

```
7E 00 03 CF 00 07 29
```

When Socket Status indicating a connection close is received, the socket ID will have been de-allocated by the XBee and no further operations are possible or necessary using that ID.

Extended Socket example: UDP

UDP is connection-less, so this example demonstrates that a Socket Connect frame is not required to begin communication and that multiple peers can be used with a single socket.

Send a Socket Create frame

Field	Value
Frame type	0x40 (Socket Create)
Frame ID	0x01
Protocol	0x00 (UDP)

UDP Socket Create frame data:

```
7E 00 03 40 01 00 BE
```

Receive a Socket Create response

Field	Value
Frame type	0xC0 (Socket Create Response)
Frame ID	0x01
Socket ID	0x00
Status	0x00 (Success)

Socket Create Response received from XBee:

```
7E 00 04 C0 01 00 00 3E
```

Bind local source address

The bind/listen operation is necessary prior to transmit in order to assign a known source address to all data sent from this socket.

Field	Value
Frame type	0x46 (Socket Bind/Listen)
Frame ID	0x01
Socket ID	0x00
Source Port	0x12 0x34

Socket Bind/Listen frame data:

```
7E 00 05 46 01 00 12 34 72
```

Receive Bind/Listen Response

The XBee generates a response indicating the status of the request to bind the requested port.

Field	Value
Frame type	0xC6 (Socket Bind/Listen Response)
Frame ID	0x01
Socket ID	0x00
Status	0x00 (Success)

Socket Bind/Listen Response received from XBee:

```
7E 00 04 C6 01 00 00 38
```

Send to Digi echo server

Digi hosts a server at 52.43.121.77 port 10001 which echos all UDP traffic sent to it.

Field	Value
Frame type	0x45 (Socket SendTo)
Frame ID	0x01
Socket ID	0x00
Destination Address	0x34 0x2B 0x79 0x4D (52.43.121.77)
Destination Port	0x27 0x11 (decimal 10001)
Transmit Options	0x00
Payload	echo this

Socket SendTo frame data:

```
7E 00 13 45 01 00 34 2B 79 4D 27 11 00 65 63 68 6F 20 74 68 69 73 E5
```

Receive TX Status

Extended sockets use the existing TX Status frame (0x89) to report acceptance of the data for transmit.

Field	Value
Frame type	0x89 (TX Status)
Frame ID	0x01
Status	0x00 (Success)

TX Status received from XBee:

```
7E 00 03 89 01 00 75
```

Receive echoed data

When the response from the server is sent back, the XBee provides it using a Socket Receive From frame.

Field	Value
Frame type	0xCE (Socket Receive From)
Frame ID	0x00
Socket ID	0x00

Field	Value
Source Address	0x34 0x2B 0x79 0x4D (52.43.121.77)
Source Port	0x27 0x11 (decimal 10001)
Status	0x00 (Success)
Payload	echo this

Socket ReceiveFrom received from XBee, containing echoed data:

```
7E 00 13 CE 00 00 34 2B 79 4D 27 11 00 65 63 68 6F 20 74 68 69 73 5D
```

Send to Digi time server

Digi hosts a server at 54.43.121.77 port 10002 which will reply with the time when it receives a packet.

Field	Value
Frame type	0x45 (Socket SendTo)
Frame ID	0x01
Socket ID	0x00
Destination Address	0x34 0x2B 0x79 0x4D (52.43.121.77)
Destination Port	0x27 0x12 (decimal 10002)
Transmit Options	0x00
Payload	0x20 (ASCII space, any value should do)

Socket SendTo time server frame data:

```
7E 00 0B 45 01 00 34 2B 79 4D 27 12 00 20 3B
```

Receive TX Status

This is exactly the same as the previous transmission to the echo server on success.

Receive daytime value

When the response from the server is sent back, the XBee will provide it using a Socket Receive From frame.

Field	Value
Frame type	0xCE (Socket Receive From)
Frame ID	0x00

Field	Value
Socket ID	0x00
Source Address	0x34 0x2B 0x79 0x4D (52.43.121.77)
Source Port	0x27 0x12 (decimal 10002)
Status	0x00 (Success)
Payload	<current UTC time>

Socket Receive From frame received from XBee containing time data:

```
7E 00 1E CE 00 00 34 2B 79 4D 27 12 00 32 30 31 39 2D 30 37 2D 31 38 20 31 38 3A 35 32 3A 34 33 0A 08
```

Close the socket

When the socket is no longer needed it should be closed to return resources to the system.

Field	Value
Frame type	0xC3 (Socket Close)
Frame ID	0x01
Status	0x00

Socket Close frame data:

```
7E 00 03 43 01 00 BB
```

Receive close response

Finally, the XBee indicates the socket has been closed with a Socket Close Response frame.

Field	Value
Frame type	0xC3 (Socket CloseResponse)
Frame ID	0x01
Socket ID	0x00
Status	0x00 (Success)

Socket Close Response received from XBee:

```
7E 00 04 C3 01 00 00 3B
```

Extended Socket example: TCP Listener

The following example demonstrates setting up a TCP listener on the XBee Cellular and interacting with incoming connections. It will open up a listener socket on a given port and then receive data

from a client.

Note The module must either have a public IP or be on a private network in order to be accessible as a server (listener).

Send a Socket Create frame

Note The XBee Cellular does not support incoming TLS sockets.

Field	Value
Frame type	0x40 (Socket Create)
Frame ID	0x01
Protocol	0x01 (TCP)

Socket Create frame data:

```
7E 00 03 40 01 01 BD
```

Receive a Socket Create response

The response contains the socket ID assigned. This example assumes zero.

Field	Value
Frame type	0xC0 (Socket Create Response)
Frame ID	0x01
Socket ID	0x00
Status	0x00 (Success)

Socket Create Response received from XBee:

```
7E 00 04 C0 01 00 00 3E
```

Designate the socket as a listener

The Socket Bind/Listen Frame takes the socket ID from the socket create response and a source port that the socket will then listen on. In this example port 10001 is used.

Field	Value
Frame type	0x46 (Socket Listen)
Frame ID	0x01
Socket ID	0x00
Source Port	0x2711 (10001)

Socket Bind/Listen frame data:

```
7E 00 05 46 01 00 27 11 80
```

Receive a Socket Bind/Listen Response

The Socket Bind/Listen Response contains a Status. A Status of zero is a success and any other value is an error.

Field	Value
Frame type	0xC6 (Socket Listen)
Frame ID	0x01
Socket ID	0x00
Status	0x00 (Success)

Socket Bind/Listen frame received from XBee:

```
7E 00 04 C6 01 00 00 38
```

Making a connection to the listener socket

The IP of the XBee can be acquired through the [MY AT command](#).

```
ATMY
172.20.1.235
```

Using an external tool like netcat, a connection can be made to the given address.

```
nc -p 10001 172.20.1.235 10001
Hello XBee!
```

After the connection has been made, the XBee outputs a Socket New IPv4 Client frame indicating the presence of a new client connection. It contains the listener's socket ID and the new Client Socket ID along with the connection's remote address information.

Field	Value
Frame type	0xCC (Socket New IPv4 Client)
Socket ID	0x00
Client Socket ID	0x01
Remote Address	0x0A 0x0A 4A 9D
Remote Port	0x27 0x11

Socket New IPv4 Client frame:

```
7E 00 09 CC 00 01 0A 0A 4A 9D 27 11 FF
```

Note XBee Cellular Cat-1 variants require data to be sent before the connection is presented. Other variants present the connection as soon as it is made.

Receiving Data from the new socket

After the connection is established, data received from the new socket is contained in a Socket Receive frame just like any other TCP socket.

Field	Value
Frame type	0xCD (Socket Status)
Frame ID	0x01
Socket ID	0x01
Status	0x00
Payload	Hello XBee!

Receive Data indicating data from remote TCP peer:

```
7E 00 10 CD 00 01 00 48 65 6C 6C 6F 20 58 42 65 65 21 0A 8E
```

Receive a Socket Status indicating closed connection

You may close the client socket remotely which elicits a Socket Status with a Status of 0x07.

Field	Value
Frame type	0xCF (Socket Status)
Socket ID	0x01
Status	0x07 (Connection lost)

Socket Status received from XBee indicating connection lost:

```
7E 00 03 CF 01 07 28
```

When a Socket Status indicating a connection close is received, the socket ID will have been de-allocated by the XBee and no further operations are possible or necessary using that ID.

Transport Layer Security (TLS)

For detailed information about using MicroPython on the XBee Cellular Modem refer to the [Digi MicroPython Programming Guide](#).

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Specifying TLS keys and certificates

These AT commands, when used together, let you interact with TLS features: [ATFS \(File System\)](#), [TL \(TLS Protocol Version\)](#), [IP \(IP Protocol\)](#), [\\$0 \(TLS Profile 0\)](#), [\\$1 \(TLS Profile 1\)](#), and [\\$2 \(TLS Profile 2\)](#). The format of the \$ commands is:

AT\$<num>[<ca_cert>];[<client_cert>];[<client_key>]

Where:

- **num**: Profile index. Index zero is used for Transparent mode connections and TLS connections using [Transmit \(TX\) Request: IPv4 - 0x20](#).
- **ca_cert**: (optional) Filename of a file in the **certs/** directory. Indicates the certificate identifying a trusted root certificate authority (CA) to use in validating servers. If **ca_cert** is empty the server certificate will not be authenticated. This must be a single root CA certificate. The modules do not allow a non-self signed certificate to work, so intermediate CAs are not enough.
- **client_cert**: (optional) Filename of a file in the **certs/** directory. Indicates the certificate presented to servers when requested for client authentication. If **client_cert** is empty no certificate is presented to the server should it request one. This may result in mutual authentication failure.
- **client_key**: (optional) Filename of a file in the **certs/** directory. Indicates the private key matching the public key contained in **client_cert**. This should be a secure file uploaded with [ATFS XPUT filename](#). This should always be provided if **client_cert** is provided and match the certificate or client authentication will fail.

The default value is ";;". This default value preserves the legacy behavior by allowing the creation of encrypted connections that are confidential but not authenticated.

To specify a key stored outside of **certs/**, you can either use a relative path, for example **../server.pem** or an absolute path starting with **/flash**, for example **/flash/server.pem**. Both examples refer to the same file.

It is not an error at configuration time to name a file that does not yet exist. An error is generated if an attempt to create a TLS connection is made with improper settings.

- Files specified should all be in PEM format, not DER.
- Upload private keys securely with [ATFS XPUT filename](#).
- Certificates can be uploaded with [ATFS PUT filename](#) as they are not sensitive. It is not possible to use [ATFS GET filename](#) to **GET** them if they have been securely uploaded.

To authenticate a server not participating in a public key infrastructure (PKI) using CAs, the server must present a self-signed certificate. That certificate can be used in the **ca_cert** field to authenticate that single server.

There are effectively three levels of authentication provided depending on the parameters provided

1. No authentication: None of the parameters are provided, this is the default value. With this configuration identity is not validated and a man in the middle (MITM) attack is possible.
2. Server authentication: Only **ca_cert** is provided. Only the servers identity is checked
3. Mutual authentication: All items are provided and both sides are assured of the identity of their peer

It is not possible to only have client authentication.

Transparent mode and TLS

Transparent mode connections made when **IP (IP Protocol) = 4** (TLS) are made using the configuration specified by **\$0 (TLS Profile 0)**.

API mode and TLS

On the **Transmit (TX) Request: IPv4 - 0x20** frame, when you specify protocol **4** (TLS), the profile configuration specified by **\$0 (TLS Profile 0)** is used to form the TLS connection. **Tx Request with TLS Profile - 0x23** lets you choose the IP setting for the serial data.

Key formats

The RSA PKCS#1 format is the only common format across XBee Cellular device variants. You can identify a PKCS#1 key file by the presence of **BEGIN RSA PRIVATE KEY** in the file header.

Digi's implementation does not support encrypted keys, we use file system encryption to protect the keys at rest in the system.

Certificate formats

The XBee Cellular 3G Global Embedded Modem does not support X509 v3 certificates and extensions for the client certificate. However, v3 certificates are fine for CA certificates used in server authentication.

Certificate limitations

The XBee Cellular Modem only supports certificate files that contain a single certificate in them. The implications of this are:

- For client certificate files (for example when client authentication is required):
 - Self-signed certificates will work.
 - Certificates signed by the root CA will work, because the root CA can be omitted per RFC 5246. The root certificate authority may be omitted from the chain, under the assumption that the remote end must already possess it in order to validate it in any case.
 - Certificate chains that include an intermediate CA are problematic. To work around this the client's certificate chain has to be supplied to the server outside of the connection.
- For server certificate files (when server authentication is required) this is not a problem unless the client is expected to connect to multiple servers that are using different self signed certificates or are using certificate chains that are signed by different root CA certificates. To work around this you have to change the certificates before making the connection, or in the case of API mode specify a different authentication profile.

Server Name Indication (SNI)

We do not currently support SNI. Therefore servers which use SNI to present certificates based on client provided host data may be unable to establish the expected connections.

Secure the connection between an XBee and Remote Manager with server authentication

The XBee devices can secure the TLS connection to Digi Remote Manager. The default configuration provides confidentiality of the communication but is not able to authenticate the server without a certificate being provided.

You should follow the procedure below to add the necessary certificate if server authentication is needed.

Step 1: Get the certificate

1. Navigate to the **Firmware Updates** section of the [Digi XBee Cellular 3G support page](#).
2. Click **Remote Manager TLS Public Certificate** to download the certificate .zip file.
3. Unzip the .zip file.
4. Calculate the SHA-256 hash to verify that the file is correct. The correct file will have an SHA-256 hash of:

33d91e18668b0d8a9ec59c5f9f312c53ca2884adaa62337839e5495c26d2d64c

Step 2: Configure device

You should confirm that the default settings are correct. You can use either Remote Manager or XBee Studio to verify these settings and place the certificate file in the correct location.

1. Verify the following settings:

Setting	Value
DO	Bit 0 (mask 0x1) must be set. This enables the use of Digi Remote Manager within the firmware.
MO	Bit 1 (mask 0x2) must be set. When this value is set the Remote Manager TCP connection will be secured with TLS.
\$D	By default will contain the value <code>/flash/cert/digi-remote-mgr.pem</code> . This is the file system location where the firmware will look for the certificate to use.

2. Use XBee Studio or Remote Manager to place the downloaded and unzipped certificate file in the location specified in the **\$D** command.

Step 3: Verify that authentication is being performed

The next TCP connection to Remote Manager should only succeed if the server can be authenticated using the provided certificate. You can confirm that the server has been authenticated.

1. Cause an active connection to Remote Manager. For example, you could set bit 0 for the **MO** command. Make sure that you do not clear bit 1.

2. After a short wait you should be able to see the device as connected in Remote Manager.
 - a. [Log in to Remote Manager](#).
 - b. Click **Device Management**.
 - c. Locate the device in the device list and verify that the connection icon in the left column is blue and the hover tool tip says "Connected".
3. When the device is connected to Remote Manager, the **DI** command can take on any of the three values shown below, based on the security level of the connection. Verify the that the **DI** command is set to **6** to verify that the server was correctly authenticated.
 - **0**: Connected without TLS
 - **5**: Connected with TLS but without authentication
 - **6**: Connected with TLS and with authentication

AT commands

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Special commands

The following commands are special commands.

AC (Apply Changes)

Immediately applies new settings without exiting Command mode.

Applying changes means that the device re-initializes based on changes made to its parameter values. Once changes are applied, the device immediately operates according to the new parameter values.

This behavior is in contrast to issuing the **WR** (Write) command. The **WR** command saves parameter values to non-volatile memory, but the device still operates according to previously saved values until the device is rebooted or you issue the **CN** (Exit AT Command Mode) or **AC** commands.

Parameter range

N/A

Default

N/A

FR (Force Reset)

Resets the device. The device responds immediately with an **OK** and performs a reset 100 ms later.

If you issue **FR** while the device is in Command Mode, the reset effectively exits Command mode.

Note Digi recommends shutting down the cellular component before resetting or rebooting the device to allow the cellular module to detach from the network. The cellular component can be shut down by issuing the [SD command](#).

Parameter range

N/A

Default

N/A

RE (Restore Defaults)

Restore device parameters to factory defaults.

The **RE** command does not write restored values to non-volatile (persistent) memory. Issue the **WR** (Write) command after issuing the **RE** command to save restored parameter values to non-volatile memory.

Parameter range

N/A

Default

N/A

SD (Shutdown)

Shuts down the device. When the shut down process is complete, the device returns **OK**. After the device responds **OK**, you can safely remove power from the device.

If the radio can't be fully shut down within two minutes, the device returns **ERROR**.

You can verify the state of the device using the [AI command](#). After you issue the **SD** command and a response has been returned (either **OK** or **ERROR**), issue the [AI command](#). If the shutdown was successful, **2D** is returned.

Parameter range

Parameter	Description
0	Shuts down the device. When the shut down process is complete, the device returns OK .
1	Reboots the module when the shut down completes.

Default

N/A

WR (Write)

Writes parameter values to non-volatile memory so that parameter modifications persist through subsequent resets.

Note Once you issue a **WR** command, do not send any additional characters to the device until after you receive the **OK** response.

Parameter range

N/A

Default

N/A

Cellular commands

The following AT commands are cellular configuration and data commands.

PH (Phone Number)

Reads the SIM card phone number.

If **PH** is blank, the XBee Cellular Modem is not registered to the network.

Parameter range

N/A

Default

Set by the cellular carrier via the SIM card

S# (ICCID)

Reads the Integrated Circuit Card Identifier (ICCID) of the inserted SIM.

Parameter range

N/A

Default

Set by the SIM card

IM (IMEI)

Reads the device's International Mobile Equipment Identity (IMEI).

Parameter range

N/A

Default

Set in the factory

II (Subscriber identity)

Reads the IMSI (International Mobile Subscriber Identity) from the SIM inserted into the module.

Parameter range

N/A

Default

N/A

MN (Operator)

Reads the network operator on which the device is registered.

Parameter range

N/A

MV (Modem Firmware Version)

Read the firmware version string for cellular component communications. See the related [VR \(Firmware Version\)](#) command.

Parameter range

N/A

Default

Set in the currently loaded firmware

MU (Modem firmware revision number)

Read the firmware revision number of the cellular component's radio firmware. See the related [MV \(Modem Firmware Version\)](#) command.

Parameter range

N/A

Default

Set in the currently loaded firmware

DB (Cellular Signal Strength)

Reads the absolute value of the current signal strength to the cell tower in dB. If **DB** is blank, the XBee Cellular Modem has not received a signal strength from the cellular component.

DB0 only updates when the modem is registered with the cellular tower. It is updated periodically, and not when read.

Parameter range

Parameter	Description
0	Returns the most recent, cached RSSI signal value received.
1	Returns a fresh, uncached RSSI signal value.

Returned values

0x71 - 0x33 (-113 dBm to -51 dBm) [read-only]

Default

N/A

DT (Cellular Network Time)

Reads the current network-provided local time of the XBee device, as reported by the cellular tower.

If the time is not known, the response is empty. If the radio reported the time zone, that information is included in the response.

This value is synchronized with the network at least once per hour.

Note The time is provided by the network. If the time is not what you expect, contact your network provider.

Parameter range

0 - 1

Value	Description
0	The response is the number of seconds since 2000-01-01 00:00:00, as a

Value	Description
	32-bit number. This is the default.
1	The response is the current date and time in ISO 8601 format. If the radio reported the time zone, that information is included in the response. Example (no time zone): 2022-12-25T22:00:05 Example (with time zone): 2022-05-23T15:45:46-05:00

Note You can also send **DT**, which acts like **DT=0**.

Default

0

AN (Access Point Name)

Specifies the packet data network that the modem uses for Internet connectivity. This information is provided by your cellular network operator. After you set this value, applying changes with [AC \(Apply Changes\)](#) or [CN \(Exit Command mode\)](#) triggers a network reset.

Parameter range

1 - 100 ASCII characters

Default

-

AM (Airplane Mode)

When set, the cellular component of the XBee Cellular Modem is fully turned off and no access to the cellular network is performed or possible.

Parameter range

0 - 1

0 = Normal operation

1 = Airplane mode

Default

0

PN (SIM PIN)

Specifies the PIN when using a SIM.

This command is write-only.

Parameter range

4 to 8 ASCII digits or space character.

A value of a single space character (ASCII 0x20) acts as an empty value.

Default

0x20: A single ASCII space character that indicates there is no PIN.

PK (SIM PUK)

Specifies the PUK for unlocking a SIM. This is needed only if the wrong PIN was used and the SIM is locked out.

This command is write-only.

Parameter range

8 ASCII digits or space character

A value of a single space character (ASCII 0x20) acts as an empty value.

Default

0x20: A single ASCII space that indicates there is no PUK.

CU (Cellular user name)

Specifies the user name used when authenticating to the cellular network.

This command is write-only.

Parameter range

1 to 30 ASCII characters

A value of a single space character (ASCII 0x20) acts as an empty value.

Default

0x20: A single ASCII space that indicates there is no cellular user name.

CW (Cellular password)

Specifies the password used when authenticating to the cellular network.

This command is write-only.

Parameter range

1 to 30 ASCII characters

A value of a single space character (ASCII 0x20) acts as an empty value.

Default

0x20: A single ASCII space that indicates there is no cellular password.

OT (Operating Technology)

Reports the active technology of the current network connection.

A blank value (OK returned) indicates that the access technology is currently unknown.

Range

0x0 - 0xFFFF

Parameter	Description
0	GSM
2	UTRAN

Default

N/A

FC (Frequency Channel Number)

Returns the (U)ARFCN of the current cellular connection.

The (U)ARFCN encodes the carrier frequency or frequencies that the cellular radio is using. Refer to the [3GPP specifications](#) or various online tools or guides to determine the corresponding band number.

If the value cannot be retrieved for some reason, such as the device is not on the network, the response is empty. When in command mode and the value cannot be retrieved, **OK** is returned.

Parameter range

N/A

Default

N/A

Network commands

The following commands are network commands.

IP (IP Protocol)

Sets or displays the IP protocol used for client and server socket connections in IP socket mode.

Parameter range

0 - 4

Value	Description
0x00	UDP
0x01	TCP
0x02	SMS
0x03	Reserved
0x04	TLS over TCP communication

Default

0x01

TL (TLS Protocol Version)

Sets the TLS protocol version used for the TLS socket. If you change the **TL** value, it does not affect any currently open sockets. The value only applies to subsequently opened sockets.

Note Due to known vulnerabilities in prior protocol versions, we strongly recommend that you use the latest TLS version whenever possible.

Range

Value	Description
0x00	SSL v3
0x01	TLS v1.0
0x02	TLS v1.1
0x03	TLS v1.2

Default

0x03

\$0 (TLS Profile 0)

Specifies the TLS certificate(s) to use in Transparent mode (when [IP \(IP Protocol\) = 4](#)) or API mode ([Transmit \(TX\) Request: IPv4 - 0x20](#) or [Tx Request with TLS Profile - 0x23](#) with profile set to 0).

Format**server_cert;client_cert;client_key****Parameter range**

From 1 through 127 ASCII characters.

Default

N/A

\$1 (TLS Profile 1)

Specifies the TLS certificate(s) to use for [Tx Request with TLS Profile - 0x23](#) transmissions with profile set to 1.

Format**server_cert;client_cert;client_key****Parameter range**

From 1 through 127 ASCII characters.

Default

N/A

\$2 (TLS Profile 2)

Specifies the TLS certificate(s) to use for [Tx Request with TLS Profile - 0x23](#) transmissions with profile set to 2.

Format**server_cert;client_cert;client_key**

Parameter range

From 1 through 127 ASCII characters.

Default

N/A

TM (IP Client Connection Timeout)

The IP client connection timeout. If there is no activity for this timeout then the connection is closed. If **TM** is 0, the connection is closed immediately after the device sends data.

If you change the **TM** value while in Transparent Mode, the current connection is immediately closed. Upon the next transmission, the **TM** value applies to the newly created socket.

If you change the **TM** value while in API Mode, the value only applies to subsequently opened sockets.

TM does not apply to explicit sockets.

Parameter range

0 - 0xFFFF [x 100 ms]

Default

0xBB8 (5 minutes)

TS (IP Server Connection Timeout)

The IP server connection timeout. If no activity for this timeout then the connection is closed. When set to 0 the connection is closed immediately after data is sent.]

Parameter Range

10 - 0xFFFF; (x 100 ms)

Default

3000

DO (Device Options)

Enables and disables special features on the XBee Cellular Modem.

2G fallback

The XBee Cellular Modem device is capable of supporting 2G (GSM/GPRS) fallback when a 3G network is not available. However, connecting to a 2G network draws bursts of current from the power supply in excess of 2.5 A. This may cause host equipment, including the standard XBee development board, to brown out. Therefore, if you enable 2G fallback mode you must observe the special considerations given in [Power supply considerations](#).

After changing this setting, you must:

1. Use [WR \(Write\)](#) to write all values to flash.
2. Use [SD \(Shutdown\)](#) to safely power down the cellular modem.
3. Use [FR \(Force Reset\)](#) to reset the device.
4. Wait for the cellular component to be initialized: [AI \(Association Indication\)](#) reaches 0x00.

The following table provides the 2G power consumption at 3.8 V and room temperature.

2G Fallback mode (3.8 V)	Average current	Peak current
GSM connected mode, max TX power (1 TX, 1 RX slot)	220 mA	2.6 A
GPRS connected mode, max TX power (4 TX, 1 RX slot)	700 mA	2.6 A
EDGE connected mode, max TX power (4 TX, 1 RX slot)	280 mA	2.6 A
2G active mode	80 mA	

Bitfield

DO value	Remote Manager	2G fallback	AT&T Configuration
0x00	Disabled	Disabled	Enabled
0x01 (default)	Enabled	Disabled	Enabled
0x02	Disabled	Enabled	Enabled
0x03	Enabled	Enabled	Enabled
0x40	Disabled	Disabled	Disabled
0x41	Enabled	Disabled	Disabled
0x42	Disabled	Enabled	Disabled
0x43	Enabled	Enabled	Disabled

Bit	Description
0	Enable Remote Manager support Controls whether Remote Manager is enabled. Digi recommends that Remote Manager remains enabled.
1	Enable 2G fallback See 2G fallback .
2-5	Reserved for future use
6	Disable AT&T configuration Set bit 6 to disable cellular configuration specific to AT&T in the United States. This should only be enabled if you are operating the device in Europe and the device takes a long time to reach AI = 0x00 or never reaches AI = 0x00. Support for disabling AT&T configuration was added in firmware version 11315.
7	Reserved for future use

Default

1 (Bit 0 enabled)

PG (Ping)

Sends an ICMP Echo Request to the specified host and reports round trip time when Echo Response is received. The command sends a single request with a timeout of five seconds. If five seconds elapses with no response the command will timeout and report an error.

Parameter range

Valid FQDN (Fully Qualified Domain Name) or IP address

Default

N/A

Addressing commands

The following AT commands are addressing commands.

SH (Serial Number High)

The upper digits of the unique International Mobile Equipment Identity (IMEI) assigned to this device.

Parameter range

0 - 0xFFFFFFFF [read-only]

Default

N/A

SL (Serial Number Low)

The lower digits of the unique International Mobile Equipment Identity (IMEI) assigned to this device.

Parameter range

0 - 0xFFFFFFFF [read-only]

Default

N/A

MY (Module IP Address)

Reads the device's IP address. This command is read-only because the IP address is assigned by the mobile network.

In API mode, the address is represented as the binary four byte big-endian numeric value representing the IPv4 address.

In Transparent or Command mode, the address is represented as a dotted-quad string notation.

Parameter range

0- 15 IPv4 characters

Default

0.0.0.0

P# (Destination Phone Number)

Sets or displays the destination phone number used for SMS when **IP (IP Protocol) = 2** while in **Transparent Operating mode**. Phone numbers must be fully numeric, using ASCII digits, for example: 8889991234.

P# allows international numbers with or without the **+** prefix. If you omit **+** and are dialing internationally, you need to include the proper International Dialing Prefix for your calling region, for example, 011 for the United States.

Note For information on SMS transmissions in API mode, see [Transmit \(TX\) SMS - 0x1F](#).

Range

Device firmware versions...	Range
Ending in *16 or later	4 - 20 ASCII digits, including an optional + prefix
Ending in *11 to *15	5 - 20 ASCII digits
Ending in *10 or earlier	7 - 20 ASCII digits

Default

N/A

N1 (DNS Address)

Displays the IPv4 address of the primary domain name server.

Parameter Range

Read-only

Default

0.0.0.0 (waiting on cellular connection)

N2 (DNS Address)

Displays the IPv4 address of the secondary domain name server.

Parameter Range

Read-only

Default

0.0.0.0 (waiting on cellular connection)

DL (Destination Address)

The destination IPv4 address or fully qualified domain name used by Transparent mode.

To set the destination address to an IP address, the value must be a dotted quad, for example **XXX.XXX.XXX.XXX**.

To set the destination address to a domain name, the value must be a legal Internet host name, for example **remotemanager.digi.com**

Parameter range

0 - 128 ASCII characters

Default

0.0.0.0

OD (Operating Destination Address)

Read the destination IPv4 address currently in use by Transparent mode. The value is **0.0.0.0** if no Transparent IP connection is active.

In API mode, the address is represented as the binary four byte big-endian numeric value representing the IPv4 address.

In Transparent or Command mode, the address is represented as a dotted-quad string notation.

Parameter range

-

Default

0.0.0.0

DE (Destination port)

Sets or displays the destination IP port number used in Transparent mode.

This command reads all input as hexadecimal. All values must be entered in hexadecimal with no leading 0x. For example, the destination port 9001 has the hexadecimal value of 0x2329. The command would be entered as **ATDE 2329**.

Parameter range

0x0 - 0xFFFF

Default

0x2616

C0 (Source Port)

The IP port used to listen for incoming connections (TCP/TLS) or incoming data (UDP) when using Transparent mode or API mode with implicit sockets.

As long as a network connection is established to this port (for TCP) data received on the serial port is transmitted on the established network connection.

[IP \(IP Protocol\)](#) sets the protocol used.

For more information on using incoming connections, see [Socket behavior](#).

Parameter range

0 - 0xFFFF

Value	Description
0	Disabled
Non-0	Enabled on that port

Default

0

LA (Lookup IP Address of FQDN)

Performs a DNS lookup of the given fully qualified domain name (FQDN) and outputs its IP address.

When you issue **LA** in API mode, the IP address is formatted in binary four byte big-endian numeric value. In all other cases (for example, Command mode) the format is dotted decimal notation.

Range

Valid FQDN

Default

-

NI (Node Identifier)

Stores a string identifier. The register only accepts printable ASCII data.

Parameter range

A string of case-sensitive ASCII printable characters from 0 to 20 bytes in length.

Default

One ASCII space character (0x20)

Serial interfacing commands

The following AT commands are serial interfacing commands.

BD (Baud Rate)

Sets or displays the serial interface baud rate for communication between the device's serial port and the host.

Modified interface baud rates do not take effect until the XBee Cellular Modem exits Command mode or you issue [AC \(Apply Changes\)](#). The baud rate resets to default unless you save it with [WR \(Write\)](#) or by clicking the **Write module settings** button in XBee Studio.

Parameter range

Standard baud rates: 0x1 - 0xA

Non-standard baud rates: 0x5B9 to 0x5B8D80 (up to 6 Mb/s)

Parameter	Description
0x1	2400 b/s
0x2	4800 b/s
0x3	9600 b/s

Parameter	Description
0x4	19200 b/s
0x5	38400 b/s
0x6	57600 b/s
0x7	115200 b/s
0x8	230400 b/s
0x9	460800 b/s
0xA	921600 b/s

Default

0x3 (9600 b/s)

NB (Parity)

Set or read the serial parity settings for UART communications.

Parameter range

0x00 - 0x02

Parameter	Description
0x00	No parity
0x01	Even parity
0x02	Odd parity

Default

0x00

SB (Stop Bits)

Sets or displays the number of stop bits for the UART.

Parameter range

0 - 1

Value	Description
0	One (1) stop bit.
1	Two (2) stop bits.

Default

0

RO (Packetization Timeout)

Set or read the number of character times of inter-character silence required before transmission begins when operating in Transparent mode.

Set **RO** to **0** to transmit characters as they arrive instead of buffering them into one RF packet.

Parameter range

0 - 0xFF (x character times)

Default

3

TD (Text Delimiter)

The ASCII character used as a text delimiter for Transparent mode. When you select a character, information received over the serial port in Transparent mode is not transmitted until that character is received. To use a carriage return, set to **0xD**. Set to zero to disable text delimiter checking.

Parameter range

0 - 0xFF

Default

0x0

FT (Flow Control Threshold)

Set or display the flow control threshold.

The device de-asserts $\overline{\text{CTS}}$ when **FT** bytes are in the UART receive buffer.

Parameter range

0x9D - 0x82D

Default

0x681

AP (API Enable)

Enables the frame-based application programming interface (API) mode.

The API mode setting. The device can format the RF packets it receives into API frames and send them out the UART. When API is enabled the UART data must be formatted as API frames because Transparent mode is disabled. See [Modes](#) for more information.

Parameter range

0x00 - 0x05

Parameter	Description
0x00	API disabled (operate in Transparent mode)

Parameter	Description
0x01	API enabled
0x02	API enabled (with escaped control characters)
0x03	N/A
0x04	MicroPython REPL
0x05	Bypass mode (DEPRECATED. For diagnostic use only)

Default

0

I/O settings commands

The following AT commands are I/O settings commands.

D0 (DIO0/AD0)

Sets or displays the DIO0/AD0 configuration (pin 20).

Parameter range

0, 2 - 6

Parameter	Description
0	Disabled
1	N/A
2	Analog input
3	Digital input
4	Digital output, default low
5	Digital output, default high
6	Cellular component mirror

Default

0

D1 (DIO1/AD1)

Sets or displays the DIO1/AD1 configuration (pin 19).

Parameter range

0 - 6

Parameter	Description
0	Disabled
1	SPI_ $\overline{\text{ATTN}}$
2	ADC
3	Digital input
4	Digital output, low
5	Digital output, high
6	I ² C SCL

Default

0

D2 (DIO2/AD2)

Sets or displays the DIO2/AD2 configuration (pin 18).

Parameter range

0 - 5, 6

	Description
0	Disabled
1	SPI_CLK
2	Analog input
3	Digital input
4	Digital output, default low
5	Digital output, default high
6	N/A
7	MicroPython UART1 RTS

Default

0

D3 (DIO3/AD3)

Sets or displays the DIO3/AD3 configuration (pin 17).

Parameter range

0 - 5, 7

Parameter	Description
0	Disabled
1	SPI_SSEL
2	Analog input
3	Digital input
4	Digital output, default low
5	Digital output, default high
6	N/A
7	MicroPython UART1 CTS

Default

0

D4 (DIO4)

Sets or displays the DIO4 configuration (pin 11).

Parameter range

0, 1, 3 - 5, 7

Parameter	Description
0	Disabled
1	SPI_MOSI
2	N/A
3	Digital input
4	Digital output, default low
5	Digital output, default high
6	N/A
7	MicroPython UART1 TX

Default

0

D5 (DIO5/ASSOCIATED_INDICATOR)

Sets or displays the DIO5/ASSOCIATED_INDICATOR configuration (pin 15).

Parameter range

0, 1, 3 - 5

Parameter	Description
0	Disabled
1	Associated LED
2	N/A
3	Digital input
4	Digital output, default low
5	Digital output, default high

Default

1

D6 (DIO6/RTS)

Sets or displays the DIO6/ $\overline{\text{RTS}}$ configuration (pin 16).

Parameter range

0, 1, 3 - 5

Parameter	Description
0	Disabled
1	Flow control (input)
2	N/A
3	Digital input
4	Digital output, default low
5	Digital output, default high

Default

0

D7 (DIO7/CTS)

Sets or displays the DIO7/ $\overline{\text{CTS}}$ configuration (pin 12).

Parameter range

0, 1, 3 - 5

Parameter	Description
0	Disabled
1	Flow control (output)

Parameter	Description
2	N/A
3	Digital input
4	Digital output, default low
5	Digital output, default high

Default

0x1

D8 (DIO8/SLEEP_REQUEST)Sets or displays the DIO8/ $\overline{\text{DTR}}$ /SLP_RQ configuration (pin 9).**Parameter range**

0, 1, 3 - 5

Parameter	Description
0	Disabled
1	SLEEP_REQUEST input
3	Digital input
4	Digital output, default low
5	Digital output, default high

Default

1

D9 (DIO9/ON_SLEEP)Sets or displays the DIO9/ON_ $\overline{\text{SLEEP}}$ configuration (pin 13).**Parameter range**

0, 1, 3 - 5

Parameter	Description
0	Disabled
1	ON/ $\overline{\text{SLEEP}}$ output
3	Digital input
4	Digital output, default low
5	Digital output, default high

Default

1

P0 (DIO10/PWM0 Configuration)

Sets or displays the PWM/DIO10 configuration (pin 6).

This command enables the option of translating incoming data to a PWM so that the output can be translated back into analog form.

Parameter range

0 - 5

Parameter	Description
0	Disabled
1	RSSI PWM0 output
2	PWM0 output
3	Digital input
4	Digital output, low
5	Digital output, high

Default

0

P1 (DIO11/PWM1 Configuration)

Sets or displays the DIO11 configuration (pin 7).

Parameter range

0, 1, 3 - 6

Parameter	Description
0	Disabled
1	Fan enable. Output is low when the XBee Cellular Modem is sleeping, when turning an attached fan off when the cellular component is in a power saving mode, and also during Airplane Mode. For more information about temperature considerations, see Heat considerations and testing .
3	Digital input
4	Digital output, default low
5	Digital output, default high
6	I ² C SDA

Default

0

P2 (DIO12 Configuration)

Sets or displays the DIO12 configuration (pin 4).

Parameter range

0, 1, 3 - 5, 7

Parameter	Description
0	Disabled
1	SPI_MISO
2	N/A
3	Digital input
4	Digital output, default low
5	Digital output, default high
6	N/A
7	MicroPython UART1 RX

Default

0

PD (Pull Direction)

The resistor pull direction bit field (1 = pull-up, 0 = pull-down) for corresponding I/O lines that are set by the **PR** command.

If the bit is not set in **PR**, the device uses **PD**.

Note Resistors are not applied to disabled lines.

Parameter range

0x0 - 0x7FFF on TH, 0x0 - 0xFFFFF on SMT

Default

0 - 0x7FFF on TH

0 - 0xFFFFF on SMT

PR (Pull-up/down Resistor Enable)

Sets or displays the bit field that configures the internal resistor status for the digital input lines. Internal pull-up/down resistors are not available for digital output pins, analog input pins, or for disabled pins.

Use the **PD** command to specify whether the resistor is pull-up or pull-down.

- If you set a **PR** bit to 1, it enables the pull-up/down resistor.
- If you set a **PR** bit to 0, it specifies no internal pull-up/down resistor.

The following table defines the bit-field map for both the **PR** and **PD** commands.

Bit	I/O line	Module pin
0	DIO4	pin 11
1	DIO3/AD3	pin 17
2	DIO2/AD2	pin 18
3	DIO1/AD1	pin 19
4	DIO0/AD0	pin 20
5	DIO6/ $\overline{\text{RTS}}$	pin 16
6	DIO8/SLEEP_REQUEST	pin 9
7	DIO14/DIN	pin 3
8	DIO5/ASSOCIATE	pin 15
9	DIO9/On/ $\overline{\text{SLEEP}}$	pin 13
10	DIO12	pin 4
11	DIO10	pin 6
12	DIO11	pin 7
13	DIO7/ $\overline{\text{CTS}}$	pin 12
14	DIO13/DOOUT	pin 2

Parameter range

0 - 0x7FFF (bit field)

Default

0x7FFF

M0 (PWM0 Duty Cycle)

Sets the duty cycle of PWM0 (pin 6) for **P0** = 2, where a value of 0x200 is a 50% duty cycle.

Before setting the line as an output:

1. Enable PWM0 output (**P0 (DIO10/PWM0 Configuration)** = 2).
2. Apply the settings (use **CN (Exit Command mode)** or **AC (Apply Changes)**).

The PWM period is 64 μ s and there are 0x03FF (1023 decimal) steps within this period. When **M0** = 0 (0% PWM), **0x01FF** (50% PWM), **0x03FF** (100% PWM), and so forth.

Parameter range

0 - 0x3FF

Default

0

I/O sampling commands

The following AT commands configure I/O sampling parameters.

TP (Temperature)

Displays the temperature of the XBee Cellular Modem in degrees Celsius. The temperature value is displayed in 16-bit two's complement format. For example, **0x1A** = 26 °C, and **0xF6** = -10 °C.

Parameter range

0 - 0xFF which indicates degrees Celsius displayed in 8-bit two's complement format.

Default

N/A

IS (Force Sample)

When run, **IS** reports the values of all of the enabled digital and analog input lines. If no lines are enabled for digital or analog input, the command returns an error.

Command mode

In Command mode, the response value is a multi-line format, individual lines are delimited with carriage returns, and the entire response terminates with two carriage returns. Each line is a series of ASCII characters representing a single number in hexadecimal notation. The interpretation of the lines is:

- Number of samples. For legacy reasons this field always returns 1.
- Digital channel mask. A bit-mask of all I/O capable pins in the system. The bits set to 1 are configured for digital I/O and are included in the digital data value below. Pins D0 - D9 are bits 0 - 9, and P0 - P2 are bits 10 - 12.
- Analog channel mask. The bits set to 1 are configured for analog I/O and have individual readings following the digital data field.
- Digital data. The current digital value of all the pins set in the digital channel mask, only present if at least one bit is set in the digital channel mask.
- Analog data. Additional lines, one for each set pin in the analog channel mask. Each reading is a 10-bit ADC value for a 2.5 V voltage reference.

API operating mode

In API operating mode, **IS** immediately returns an **OK** response.

The API response is ordered identical to the Command mode response with the same fields present. Each field is a binary number of the size listed in the following table. Multi-byte fields are in big-endian byte order.

Field	Size
Number of samples	1 byte
Digital channel mask	2 bytes
Analog channel mask	1 byte
Samples	2 bytes each

Parameter range

N/A

Default

N/A

Sleep commands

The following AT commands are sleep commands.

SM (Sleep Mode)

Sets or displays the sleep mode of the device.

The sleep mode determines how the device enters and exits a power saving sleep.

In addition to the sleep modes listed below, sleep can be controlled directly by a MicroPython program. See the [Power management in MicroPython](#) section of the [Digi MicroPython Programming Guide](#). With direct control additional power savings can be realized through intelligent sleep upon immediate completion of application tasks and dynamic sleep intervals can be used to respond to changing needs.

Parameter range

0, 1, 4, 5

Parameter	Description
0	Normal. In this mode the device never sleeps.
1	Pin Sleep. In this mode the device honors the SLEEP_RQ pin. Set D8 (DIO8/SLEEP_REQUEST) to the sleep request function: 1 .
4	Cyclic Sleep. In this mode the device repeatedly sleeps for the value specified by SP and spends ST time awake.
5	Cyclic Sleep with Pin Wake. In this mode the device acts as in Cyclic Sleep but does not sleep if the SLEEP_RQ pin is inactive, allowing the device to be kept awake or woken by the connected system.

Default

0

SP (Sleep Period)

Sets or displays the time to spend asleep in cyclic sleep modes. In Cyclic sleep mode, the node sleeps with CTS disabled for the sleep time interval, then wakes for the wake time interval.

Parameter range

0x1 - 0x83D600 (x 10 ms)

Default

0x7530 (5 minutes)

ST (Wake Time)

Sets or displays the time to spend awake in cyclic sleep modes.

Parameter range

0x1 - 0x36EE80 (x 1 ms)

Default

0xEA60 (60 seconds)

Command mode options

The following commands are Command mode option commands.

CC (Command Sequence Character)

The character value the device uses to enter Command mode.

The default value (**0x2B**) is the ASCII code for the plus (+) character. You must enter it three times within the guard time to enter Command mode. To enter Command mode, there is also a required period of silence before and after the command sequence characters of the Command mode sequence (**GT + CC + GT**). The period of silence prevents inadvertently entering Command mode.

Parameter range

Recommended: 0x20 - 0x7F (ASCII)

Default

0x2B (the ASCII plus character: +)

CT (Command Mode Timeout)

Sets or displays the Command mode timeout parameter. If a device does not receive any valid commands within this time period, it returns to Idle mode from Command mode.

Parameter range

2 - 0x1770 (x 100 ms)

Default

0x64 (10 seconds)

CN (Exit Command mode)

Immediately exits Command Mode and applies pending changes.

Note Whether Command mode is exited using the **CN** command or by **CT** timing out, changes are applied upon exit.

Parameter range

N/A

Default

N/A

GT (Guard Times)

Set the required period of silence before and after the command sequence characters of the Command mode sequence (**GT** + **CC** + **GT**). The period of silence prevents inadvertently entering Command mode.

Parameter range

0x2 - 0x576 (x 1 ms)

Default

0x3E8 (one second)

MicroPython commands

The following commands relate to using MicroPython on the XBee Cellular Modem.

PS (Python Startup)

Sets whether or not the XBee Cellular Modem runs the stored Python code at startup.

Range

0 - 1

Parameter	Description
0	Do not run stored Python code at startup.
1	Run stored Python code at startup.

Default

0

PY (MicroPython Command)

Interact with the XBee Cellular Modem using MicroPython. **PY** is a command with sub-commands. These sub-commands are arguments to **PY**.

Note You can use the **PY** command options to control MicroPython from Digi Remote Manager. Refer to the [Digi MicroPython Programming Guide](#).

PYB (Bundled Code Report)

You can store compiled code in flash using the **os.bundle()** function in the MicroPython REPL; refer to the [Digi MicroPython Programming Guide](#). The **PYB** sub-command reports details of the bundled code. In Command mode, it returns two lines of text, for example:

```
bytecode: 619 bytes (hash=0x0900DBCE)
bundled: 2017-05-09T15:49:44
```

The messages are:

- **bytecode**: The size of bytecode stored in flash and its 32-bit hash. A size of **0** indicates that there is no stored code.
- **bundled**: A compilation timestamp. A timestamp of **2000-01-01T00:00:00** indicates that the clock was not set during compilation.

In API mode, **PYB** returns three 32-bit big-endian values:

- bytecode size
- bytecode hash
- timestamp as seconds since 2000-01-01T00:00:00

PYE (Erase Bundled Code)

PYE interrupts any running code, erases any bundled code and then does a soft-reboot on the MicroPython subsystem.

PYR (Soft Reset)

PYR performs a MicroPython soft reset which stops any currently executing code. If Python Startup is enabled (PS1) then the stored Python code is run.

PYV (Version Report)

Report the MicroPython version.

PY^ (Interrupt Program)

Sends **KeyboardInterrupt** to MicroPython. This is useful if there is a runaway MicroPython program and you have filled the stdin buffer. You can enter Command mode (**+++**) and send **ATPY^** to interrupt the program.

Default

N/A

Firmware version/information commands

The following AT commands are firmware version/information commands.

VR (Firmware Version)

Reads the firmware version on the device.

Parameter range

0 - 0xFFFFFF [read-only]

Default

Set in firmware

VL (Verbose Firmware Version)

Shows detailed version information including the application build date and time.

Parameter range

N/A

Default

Set in firmware

HV (Hardware Version)

Display the hardware version number of the device.

Read the device's hardware version. Use this command to distinguish between different hardware platforms. The upper byte returns a value that is unique to each device type. The lower byte indicates the hardware revision.

Parameter range

0 - 0xFFFF [read-only]

Default

Set in firmware

HS (Hardware Series)

Read the device's hardware series number.

Parameter range

N/A

Default

Set in the firmware

CK (Configuration CRC)

Displays the cyclic redundancy check (CRC) of the current AT command configuration settings.

Parameter range

0 - 0xFFFFFFFF

Default

N/A

AI (Association Indication)

Reads the Association status code to monitor association progress. The following table provides the status codes and their meanings.

Status code	Meaning
0x00	Connected to the Internet.
0x22	Registering to cellular network.
0x23	Connecting to the Internet.
0x24	The cellular component is missing, corrupt, or otherwise in error. The cellular component requires a new firmware image.
0x25	Cellular network registration denied.
0x2A	Airplane mode.
0x2B	USB Direct active.
0x2D	Modem shut down. See SD (Shutdown) .
0x2F	Bypass mode active.
0x30	An upgrade is in process.
0xFF	Initializing.

Parameter range

0 - 0xFF [read-only]

Default

N/A

Diagnostic interface commands

The following AT commands are diagnostic interface commands.

DI (Remote Manager Indicator)

Displays the current Remote Manager status for the XBee.

Range

Value	Description
0x00	Connected, but without TLS or authentication.
0x01	Before connection to the Internet.
0x02	Remote Manager connection in progress.

Value	Description
0x03	Disconnecting from Remote Manager.
0x04	Not configured for Remote Manager.
0x05	Connected over TLS.
0x06	Connected over TLS with authenticated server.

Default

N/A

CI (Protocol/Connection Indication)

Displays information regarding the last IP connection when using Transparent mode (**AP = 0**), and when **IP = 0, 1 or 4** or when **IP = 2** for an SMS transmission.

The value for this parameter resets to **0xFF** when the device switches between **IP (IP Protocol)** modes.

When **IP** is set to **0, 1, or 4** (UDP, TCP, over TLS over TCP), **CI** resets to **0xFF** when you apply changes to any of the following settings:

- **DL (Destination Address)**
- **DE (Destination port)**
- **TM (IP Client Connection Timeout)**

When **IP** is set to **2** (SMS), **CI** resets to **0xFF** when **P# (Destination Phone Number)** is changed.

The following table provides the parameter's meaning when **IP = 0** for UDP connections.

Parameter	Description
0x00	The socket is open.
0x01	Tried to send but could not.
0x02	Invalid parameters (bad IP/host).
0x10	Not registered to the cell network.
0x11	Cellular component not identified yet.
0x12	DNS query lookup failure.
0x13	Socket leak
0x20	Bad handle.
0x21	User closed.
0x22	Unknown server - DNS lookup failed.
0x23	Connection lost.
0x24	Unknown.
0xFF	No known status.

The following table provides the parameter's meaning when IP = 1 or 4 for TCP connections.

Parameter	Description
0x00	The socket is open.
0x01	Tried to send but could not.
0x02	Invalid parameters (bad IP/host).
0x03	TCP not supported on this cellular component.
0x10	Not registered to the cell network.
0x11	Cellular component not identified yet.
0x12	DNS query lookup failure.
0x13	Socket leak
0x20	Bad handle.
0x21	User closed.
0x22	No network registration.
0x23	No internet connection.
0x24	No server - timed out on connection.
0x25	Unknown server - DNS lookup failed.
0x26	Connection refused.
0x27	Connection lost.
0x28	Unknown.
0x2F	TLS Socket Authentication Error
0xFF	No known status.

The following table provides the parameter's meaning when IP = 2 for SMS connections.

Parameter	Description
0x00	SMS successfully sent.
0x01	SMS failed to send.
0x02	Invalid SMS parameters - check P# (Destination Phone Number) .
0x03	SMS not supported.
0x10	No network registration.
0x11	Cellular component stack error.
0x12	A modem update is in-progress. Try again after its completion.
0xFF	No SMS state to report (no SMS messages have been sent).

Parameter range

0 - 0xFF (read-only)

Default

-

Execution commands

The location where most AT commands set or query register values, execution commands execute an action on the device. Execution commands are executed immediately and do not require changes to be applied.

NR (Network Reset)

NR resets the network layer parameters. The XBee Cellular Modem tears down any TCP/UDP sockets and resets Internet connectivity.

The XBee Cellular Modem responds immediately with an **OK** on the UART and then causes a network restart.

Parameter range

0

Default

N/A

!R (Modem Reset)

Forces the cellular component to reboot.



CAUTION! This command is for advanced users, and you should only use it if the cellular component becomes completely stuck while in Bypass mode. Normal users should never need to run this command. See the [FR \(Force Reset\)](#) command instead.

Range

N/A

Default

N/A

File system commands

To access the file system, [Enter Command mode](#) and use the following commands. All commands block the AT command processor until completed and only work from Command mode; they are not valid for API mode or MicroPython's `xbcc.atcmd()` method. Commands are case-insensitive as are file and directory names. Optional parameters are shown in square brackets (`[]`).

FS is a command with sub-commands. These sub-commands are arguments to **FS**.

For **FS** commands, you have to type **AT** before the command, for example **ATFS PWD**, **ATFS LS** and so forth.

Error responses

If a command succeeds it returns information such as the name of the current working directory or a list of files, or **OK** if there is no information to report. If it fails, you see a detailed error message instead of the typical **ERROR** response for a failing AT command. The response is a named error code and a textual description of the error.

Note The exact content of error messages may change in the future. All errors start with a capital **E**, followed by one or more uppercase letters and digits, a space, and an description of the error. If writing your own AT command parsing code, you can determine if an **FS** command response is an error by checking if the first letter of the response is capital **E**.

ATFS (File System)

When sent without any parameters, **FS** prints a list of supported commands.

ATFS PWD

Prints the current working directory, which always starts with **/** and defaults to **/flash** at startup.

ATFS CD *directory*

Changes the current working directory to **directory**. Prints the current working directory or an error if unable to change to **directory**.

ATFS MD *directory*

Creates the directory **directory**. Prints **OK** if successful or an error if unable to create the requested directory.

ATFS LS [*directory*]

Lists files and directories in the specified directory. The **directory** parameter is optional and defaults to a period (**.**), which represents the current directory. The list ends with a blank line.

Entries start with zero or more spaces, followed by filesize or the string **<DIR>** for directories, then a single space character and the name of the entry. Directory names end with a forward slash (**/**) to differentiate them from files. Secure files end with a hash mark (**#**) and you cannot download them.

```
<DIR> ./
<DIR> ../
<DIR> cert/
<DIR> lib/
  32 test.txt
 1234 secure.bin#
```

ATFS PUT *filename*

Starts a YMODEM protocol receive on the XBee Cellular Modem, storing the received file to **filename** and ignoring the filename that appears in block 0 of the YMODEM transfer. The XBee Cellular Modem sends a prompt (**Receiving file with YMODEM...**) when it is ready to receive, at which point you should initiate a YMODEM send in your terminal emulator.

If the command is incorrect, the reply will be an error as described in [Error responses](#).

ATFS XPUT *filename*

Similar to the **PUT** command, but stores the file securely on the XBee Cellular Modem. See [Secure files](#) for details on what this means.

If the command is incorrect, the reply will be an error as described in [Error responses](#).

ATFS HASH *filename*

Print a SHA-256 hash of a file to allow for verification against a local copy of the file.

- On Windows, you can generate a SHA-256 hash of a file with the command **certutil -hashfile test.txt SHA256**.
- On Mac and Linux use **shasum -b -a 256 test.txt**.

ATFS GET *filename*

Starts a YMODEM send of **filename** on the XBee device. When it is ready to send, the XBee Cellular Modem sends a prompt: (**Sending file with YMODEM...**). When the prompt is sent, you should initiate a YMODEM receive in your terminal emulator.

If the command is incorrect, the reply will be an error as described in [Error responses](#).

ATFS MV *source_path dest_path*

Moves or renames the selected file or directory **source_path** to the new name or location **dest_path**. This command fails with an error if **source_path** does not exist, or **dest_path** already exists.

Note Unlike a computer's command prompt which moves a file into the **dest_path** if it is an existing directory, you must specify the full name for **dest_path**.

ATFS RM *file_or_directory*

Removes the file or empty directory specified by **file_or_directory**. This command fails with an error if **file_or_directory** does not exist, is not empty, refers to the current working directory or one of its parents.

ATFS INFO

Report on the size of the filesystem, showing bytes in use, available, marked bad and total. The report ends with a blank line, as with most multi-line AT command output. Example output:

```
204800 used
695296 free
      0 bad
900096 total
```

ATFS FORMAT *confirm*

Reformats the file system, leaving it with a default directory structure. Pass the word **confirm** as the first parameter to confirm the format. The XBee Cellular Modem responds with **Formatting...**, adds a period every second until the format is complete and ends the response with a carriage return.

Remote Manager commands

The following commands are used with Remote Manager.

MO (Remote Manager Options)

Configures the connection to Remote Manager.

Note When bit 0 is set to 0, you should manage the Remote Manager keepalive interval, which may otherwise result in excessive data usage. See [Configure Remote Manager keepalive interval](#).

Parameter range

0, 1, 7

Bit	Description
0	Maintains a persistent TCP connection to Remote Manager. If the XBee Cellular Modem cannot establish a connection with Remote Manager, it waits 30 seconds before trying again. On each successive connection failure, the wait time doubles (60 seconds, 120, 240, and so on) up to a maximum of 1 hour. This time resets to 30 seconds once the connection to Remote Manager succeeds or if the device is reset.
1	TCP connection uses TLS. This is the default.
2-6	Reserved for future use.
7	Sets up a constant TLS connection with SM/UDP still enabled.

Default

6 (Bits 1 and 2 are enabled by default.)

DF (Remote Manager Status Check Interval)

Defines the number of minutes between polls for Remote Manager activity.

Parameter range

1 to 0x10E0

Default

1440

EQ (Remote Manager FQDN)

Sets or display the fully qualified domain name of the Remote Manager server.

Range

From 0 through 63 ASCII characters.

Default

my.devicecloud.com

K1 (Remote Manager Server Send Keepalive)

Specify the Remote Manager Server Send Transmit Keepalive Interval value in seconds. The XBee device considers a Remote Manager connection to have failed after 3 missed keepalives.

This command works with the [K2 command](#) to limit data usage. See [Configure Remote Manager keepalive interval](#).

Note Changing this value causes any currently active Remote Manager connections to be closed and recreated.

Parameter range

10 - 7200 (x 1 s)

Default

0x258 (600 seconds)

K2 (Remote Manager Device Send Keepalive)

Specify the Remote Manager Device Send Transmit Keepalive Interval value in seconds. The Remote Manager considers a connection to have failed after 3 missed keepalives.

This command works with the [K1 command](#) to limit data usage. See [Configure Remote Manager keepalive interval](#).

Note Changing this value causes any currently active Remote Manager connections to be closed and recreated.

Parameter range

10 - 7200 (x 1 s)

Default

0x258 (600 seconds)

\$D (Remote Manager certificate)

Defines the TLS Remote Manager certificate.

Parameter range

N/A

Default

`/flash/cert/digi-remote-mgr.pem`

ER (Remote Manager TCP Port Override)

Use this command to specify a TCP port other than the default Remote Manager TCP port. The defaults are 0xC7D when unencrypted and 0xC7F when TLS is enabled.

- Value is 0: The default Remote Manager TCP port is used.
- Value is non-zero: Specify the TCP port that should be used. The default Remote Manager TCP port is overridden.

Parameter range

0x0 - 0xFFFF

Default

0x0

ES (Remote Manager UDP Port Override)

Use this command to specify a UDP port other than the default Remote Manager UDP port.

- Value is 0: The default Remote Manager UDP port is used.
- Value is non-zero: Specify the UDP port that should be used. The default Remote Manager UDP port is overridden. The default UDP port is 0xCE1.

Parameter range

0x0 - 0xFFFF

Default

0x0

MT (Remote Manager Idle Timeout)

Specify the length of time (in minutes) that a TCP connection to Remote Manager can be idle. When the time limit is met the TCP connection is closed.

For example, you can use this command to adjust the desired timeout when a TCP connection is used without a persistent connection to Remote Manager. This command can be used in conjunction with devices that use SM/UDP or SM/SMS and scheduled tasks within Remote Manager after a request connect task is performed to connect on demand. For more information on situations where this command applies, see [Configure Remote Manager features using automations](#).

This command works in conjunction with the [MO command](#). If MO bit 0 is set (to maintain a persistent TCP connection to Remote Manager), the configuration for the MT command is ignored.

Parameter range

0x1 - 0x5A0

Default

0xA

System commands

The following commands are used to assign descriptors to the XBee Cellular Modem, which distinguish the devices from each other in Remote Manager.

KL (Device Location)

Sets or displays a user-defined physical location for the XBee displayed in Remote Manager.

Range

Up to 20 ASCII characters

Default

One ASCII space character (0x20).

KP (Device Description)

Sets or displays a user-defined description for the XBee displayed in Remote Manager.

Range

Up to 20 ASCII characters

Default

One ASCII space character (0x20)

KC (Contact Information)

Sets or displays user-defined contact information for the XBee displayed in Remote Manager.

Range

Up to 20 ASCII characters

Default

One ASCII space character (0x20).

Socket commands

The following AT commands are socket commands.

SI (Socket Info)

Lists either information about a given socket or lists the socket IDs of all active (open) sockets on the modem in a human-readable format.

When the **SI** command is issued without a parameter, the XBee outputs a list of socket IDs in hex, separated by carriage returns (<CR>). After the last socket ID has been printed the list is terminated with an additional carriage return.

In both API and command mode the payload (output) will have the following format:

```
ID<CR>
ID<CR>
...
ID<CR>
<CR>
```

In the list of socket IDs, an asterisk (*) displays after the socket ID for non-Extended API Sockets (which are sockets created implicitly when using IPv4 TX API frames). In the example below, the 0x00 socket is an IPv4 TX/RX socket, and the 0x01 and 0x02 sockets are both Extended API sockets. The socket IDs are displayed in ascending order, from smallest socket value to the largest.

```
0x00*
0x01
0x02
```

Note When sending AT commands for API frames it is standard to send the command as ASCII text and the parameters for that command as binary.

When the **SI** command is issued with a socket ID, specified in hex, the response is a list of information about the socket. The list is separated by carriage returns (<CR>) and terminated with an additional carriage return.

In both API and command mode the payload/output will have the following format:

```
ID<CR>
STATE<CR>
PROTOCOL<CR>
LOCAL_PORT<CR>
REMOTE_PORT<CR>
REMOTE_ADDRESS<CR>
<CR>
```

Field	Description
ID	The socket ID.
STATE	The state of the socket: ■ ALLOCATED ■ CONNECTING ■ CONNECTED ■ LISTENING ■ BOUND ■ CLOSING
PROTOCOL	The protocol of the socket: ■ UDP ■ TCP ■ TLS
LOCAL_PORT	The local port of the socket. This is 0 unless the socket is explicitly bound to a port.
REMOTE_PORT	The remote port of the socket.
REMOTE_ADDRESS	The remote IPv4 address for the given socket. This is 0.0.0.0 for an unconnected socket.

Parameter range

0x00 - 0xFE

Default

-

Operate in API mode

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API mode overview

As an alternative to Transparent operating mode, you can use API operating mode. API mode provides a structured interface where data is communicated through the serial interface in organized packets and in a determined order. This enables you to establish complex communication between devices without having to define your own protocol. The API specifies how commands, command responses and device status messages are sent and received from the device using the serial interface or the SPI interface.

We may add new frame types to future versions of firmware, so build the ability to filter out additional API frames with unknown frame types into your software interface.

Use the AP command to set the operation mode

Use [AP \(API Enable\)](#) to specify the operation mode:

AP command setting	Description
AP = 0	Transparent operating mode, UART serial line replacement with API modes disabled. This is the default option.
AP = 1	API operation.
AP = 2	API operation with escaped characters (only possible on UART).
AP = 3	N/A
AP = 4	MicroPython REPL
AP = 5	Bypass mode. This mode is for direct communication with the underlying chip and is only for advanced users.

The API data frame structure differs depending on what mode you choose.

API frame format

An API frame consists of the following:

- Start delimiter
- Length
- Frame data
- Checksum

API operation (AP parameter = 1)

This is the recommended API mode for most applications. The following table shows the data frame structure when you enable this mode:

Frame fields	Byte	Description
Start delimiter	1	0x7E
Length	2 - 3	Most Significant Byte, Least Significant Byte
Frame data	4 - number (n)	API-specific structure
Checksum	n + 1	1 byte

Any data received prior to the start delimiter is silently discarded. If the frame is not received correctly or if the checksum fails, the XBee replies with a radio status frame indicating the reason for the failure.

API operation with escaped characters (AP parameter = 2)

Setting API to 2 allows escaped control characters in the API frame. Due to its increased complexity, we only recommend this API mode in specific circumstances. API 2 may help improve reliability if the serial interface to the device is unstable or malformed frames are frequently being generated.

When operating in API 2, if an unescaped 0x7E byte is observed, it is treated as the start of a new API frame and all data received prior to this delimiter is silently discarded. For more information on using this API mode, see the [Escaped Characters and API Mode 2](#) in the Digi Knowledge base.

API escaped operating mode works similarly to API mode. The only difference is that when working in API escaped mode, the software must escape any payload bytes that match API frame specific data, such as the start-of-frame byte (0x7E). The following table shows the structure of an API frame with escaped characters:

Frame fields	Byte	Description
Start delimiter	1	0x7E
Length	2 - 3	Most Significant Byte, Least Significant Byte
Frame data	4 - n	API-specific structure
Checksum	n + 1	1 byte

Start delimiter field

This field indicates the beginning of a frame. It is always 0x7E. This allows the device to easily detect a new incoming frame.

Escaped characters in API frames

If operating in API mode with escaped characters (AP parameter = 2), when sending or receiving a serial data frame, specific data values must be escaped (flagged) so they do not interfere with the data frame sequencing. To escape an interfering data byte, insert 0x7D and follow it with the byte to be escaped (XORed with 0x20).

The following data bytes need to be escaped:

- 0x7E: start delimiter
- 0x7D: escape character
- 0x11: XON
- 0x13: XOFF

To escape a character:

1. Insert 0x7D (escape character).
2. Append it with the byte you want to escape, XORed with 0x20.

In API mode with escaped characters, the length field does not include any escape characters in the frame and the firmware calculates the checksum with non-escaped data.

Example: escape an API frame

To express the following API non-escaped frame in API operating mode with escaped characters:

Start delimiter	Length	Frame type	Frame Data														Checksum
			Data														
7E	00 0F	17	01 00 13 A2 00 40 AD 14 2E FF FE 02 4E 49 6D														

You must escape the 0x13 byte:

1. Insert a 0x7D.
2. XOR byte 0x13 with 0x20: $13 \oplus 20 = 33$

The following figure shows the resulting frame. Note that the length and checksum are the same as the non-escaped frame.

Start delimiter	Length	Frame type	Frame Data														Checksum
			Data														
7E	00 0F	17	01 00 7D 33 A2 00 40 AD 14 2E FF FE 02 4E 49 6D														

The length field has a two-byte value that specifies the number of bytes in the frame data field. It does not include the checksum field.

Length field

The length field is a two-byte value that specifies the number of bytes contained in the frame data field. It does not include the checksum field.

Frame data

This field contains the information that a device receives or will transmit. The structure of frame data depends on the purpose of the API frame:

Start delimiter	Length		Frame type	Frame data							Checksum
				Data							
1	2	3	4	5	6	7	8	9	...	n	n+1
0x7E	MSB	LSB	API frame type	Data							Single byte

- **Frame type** is the API frame type identifier. It determines the type of API frame and indicates how the Data field organizes the information.
- **Data** contains the data itself. This information and its order depend on the what type of frame that the Frame type field defines.

Multi-byte values are sent big-endian.

Calculate and verify checksums

To calculate the checksum of an API frame:

1. Add all bytes of the packet, except the start delimiter 0x7E and the length (the second and third bytes).
2. Keep only the lowest 8 bits from the result.
3. Subtract this quantity from 0xFF.

To verify the checksum of an API frame:

1. Add all bytes including the checksum; do not include the delimiter and length.
2. If the checksum is correct, the last two digits on the far right of the sum equal 0xFF.

Example

Consider the following sample data packet: **7E 00 08 08 01 4E 49 58 42 45 45 3B**

Byte(s)	Description
7E	Start delimiter
00 08	Length bytes
08	API identifier
01	API frame ID
4E 49	AT Command
58 42 45 45	Parameter value
3B	Checksum

To calculate the check sum you add all bytes of the packet, excluding the frame delimiter **7E** and the length (the second and third bytes):

7E 00 08 08 01 4E 49 58 42 45 45 3B

Add these hex bytes:

$$0x08 + 0x01 + 0x4E + 0x49 + 0x58 + 0x42 + 0x45 + 0x45 = 0x0147$$

Now take the result of 0x0147 and keep only the lowest 8 bits which in this example is 0x47 (the two far right digits). Subtract 0x47 from 0xFF and you get 0x3B (0xFF - 0x47 = 0x3B). 0x3B is the checksum for this data packet.

If an API data packet is composed with an incorrect checksum, the XBee Cellular Modem will consider the packet invalid and will ignore the data.

To verify the check sum of an API packet add all bytes including the checksum (do not include the delimiter and length) and if correct, the last two far right digits of the sum will equal FF.

$$0x08 + 0x01 + 0x4E + 0x49 + 0x58 + 0x42 + 0x45 + 0x45 + 0x3B = 0x01FF$$

API frames

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AT Command - 0x08

Description

Use this frame to query or set parameters on the local device. Changes this frame makes to device parameters take effect after executing the AT command.

Format

The following table provides the contents of the frame. For details on frame structure, see [API frame format](#).

Field name	Field value	Data type	Description
Frame type	0x08	Byte	
Frame ID		Byte	Identifies the data frame for the host to correlate with a subsequent ACK. If set to 0, the device does not send a response.
AT command		Byte	Command name: two ASCII characters that identify the AT command.
Parameter value		Byte	If present, indicates the requested parameter value to set the given register. If no characters are present, it queries the register.

AT Command: Queue Parameter Value - 0x09

Description

This frame allows you to query or set device parameters. In contrast to [AT Command - 0x08](#), this frame queues new parameter values and does not apply them until you issue either:

- The AT Command (0x08) frame
- The **AC** command

When querying parameter values, the 0x09 frame behaves identically to the 0x08 frame. The device returns register queries immediately and does not queue them. The response for this command is also an AT Command Response frame (0x88).

Format

The following table provides the contents of the frame. For details on frame structure, see [API frame format](#).

Field name	Field value	Data type	Description
Frame type	0x09	Byte	
Frame ID		Byte	Identifies the data frame for the host to correlate with a subsequent ACK. If set to 0 , the device does not send a response.
AT command		Byte	Command name: two ASCII characters that identify the AT command.
Parameter value		Byte	If present, indicates the requested parameter value to set the given register. If no characters are present, it queries the register.

Transmit (TX) SMS - 0x1F

Description

Transmit an SMS message. The frame allows international numbers with or without the + prefix. If you omit + and are dialing internationally, you need to include the proper International Dialing Prefix for your calling region, for example, 011 for the United States.

Format

The following table provides the contents of the frame. For details on frame structure, see [API frame format](#).

Field name	Field value	Data type	Description
Frame type	0x1F	Byte	
Frame ID		Byte	Reference identifier used to match status responses. 0 disables the TX Status frame.
Options		Byte	Reserved for future use.
Phone number		20 byte string	String representation of phone number terminated with a null (0x0) byte. Use numbers and the + symbol only, no other symbols or letters.
Payload		Variable (160 characters maximum)	Data to send as the body of the SMS message.

Transmit (TX) Request: IPv4 - 0x20

Description

A TX Request message causes the device to transmit data in IPv4 format. A TX request frame for a new destination creates a network socket. After the network socket is established, data from the network that is received on the socket is sent out the device's serial port in the form of a Receive (RX) Packet frame.

Format

The following table provides the contents of the frame. For details on frame structure, see [API frame format](#).

Field name	Field value	Data type	Description
Frame type	0x20	Byte	
Frame ID		Byte	Reference identifier used to match status responses. 0 disables the TX Status frame.
Destination address		32-bit big endian	
Destination port		16-bit big endian	
Source port		16-bit big endian	If the source port is 0 , the device attempts to send the frame data using an existing open socket with a destination that matches the destination address and destination port fields of this frame. If there is no matching socket, then the device attempts to open a new socket. If the source port is non-zero, the device attempts to send the frame data using an existing open socket with a source and destination that matches the source port, destination address, and destination port fields of this frame. If there is no matching socket, it returns an error.
Protocol		Byte	0 = UDP 1 = TCP 4 = SSL over TCP
Transmit options		Byte bitfield	Bit fields are offset 0 Bit field 0 - 7. Bits 0, and 2-7 are reserved, bit 1 is not. BIT 1 = 1 - Terminate the TCP socket after transmission is complete 0 - Leave the socket open. Closed by timeout, see TM (IP Client Connection Timeout) .

Field name	Field value	Data type	Description
			Ignore this bit for UDP packets. All other bits are reserved and should be 0.
Payload		Variable	Data to be transferred to the destination, may be up to 1500 bytes.

Tx Request with TLS Profile - 0x23

Description

The frame gives greater control to the application over the TLS settings used for a connection.

A TX Request with TLS Profile frame implies the use of TLS and behaves similar to the TX Request (0x20) frame, with the protocol field replaced with a TLS Profile field to choose from the profiles configured with the \$0, \$1, and \$2 configuration commands.

Format

The following table provides the contents of the frame. For details on frame structure, see [API frame format](#).

Field name	Field value	Data type	Description
Frame type	0x23	Byte	
Frame ID		Byte	Reference identifier used to match status responses. 0 disables the TX Status frame.
Destination address		32-bit big endian	
Destination port		16-bit big endian	
Source port		16-bit big endian	If the source port is 0 , the device attempts to send the frame data using an existing open socket with a destination that matches the destination address and destination port fields of this frame. If there is no matching socket, then the device attempts to open a new socket. If the source port is non-zero, the device attempts to send the frame data using an existing open socket with a source and destination that matches the source port, destination address, and destination port fields of this frame. If there is no matching socket, the TX Status frame returns an error.
TLS profile		Byte	Zero-indexed number that indicates the profile as

Field name	Field value	Data type	Description
			specified by the corresponding \$<num> command.
Transmit options		Byte bitfield	Bit fields are offset 0 Bit field 0 - 7. Bits 0, and 2-7 are reserved, bit 1 is not. BIT 1 = 1 - Terminate the TCP socket after transmission is complete 0 - Leave the socket open. Closed by timeout, see TM (IP Client Connection Timeout) . Ignore this bit for UDP packets. All other bits are reserved and should be 0 .
Payload		Variable	Data to be transferred to the destination, may be up to 1500 bytes.

AT Command Response - 0x88

Description

A device sends this frame in response to an AT Command (0x08) frame. Some commands send back multiple frames.

Format

The following table provides the contents of the frame. For details on frame structure, see [API frame format](#).

Field name	Field value	Data type	Description
Frame type	0x88	Byte	
Frame ID		Byte	Identifies the data frame for the host to correlate with a subsequent ACK. If set to 0 , the device does not send a response.
AT command		Byte	Command name: two ASCII characters that identify the AT command.
Status	##	Byte	0 = OK 1 = ERROR 2 = Invalid command 3 = Invalid parameter
Parameter value		Byte	Register data in binary format. If the register was set, then this field is not returned.

Transmit (TX) Status - 0x89

Description

Indicates the success or failure of a transmit operation.

Format

The following table provides the contents of the frame. For details on frame structure, see [API frame format](#).

Field name	Field value	Data type	Description
Frame type	0x89	Byte	
Frame ID		Byte	Refers to the frame ID specified in a previous transmit frame
Status		Byte	Status code (see the table below)

The following table shows the status codes.

Code	Description
0x0	Successful transmit
0x20	Connection not found
0x21	Failure to transmit to cell network
0x22	Not registered to cell network
0x2c	Invalid frame values (check the phone number)
0x31	Internal error
0x32	Resource error (retry operation later). See Socket limits in API mode for more information.
0x74	Message too long
0x76	Socket closed unexpectedly
0x78	Invalid UDP port
0x79	Invalid TCP port
0x7A	Invalid host address
0x7B	Invalid data mode
0x7C	Invalid interface. See User Data Relay - 0x2D .
0x7D	Interface not accepting frames. See User Data Relay - 0x2D .

Code	Description
0x7E	A modem update is in progress. Try again after the update is complete.
0x80	Connection refused
0x81	Socket connection lost
0x82	No server
0x83	Socket closed
0x84	Unknown server
0x85	Unknown error
0x86	Invalid TLS configuration (missing file, and so forth)
0x87	Socket not connected
0x88	Socket not bound
0x8B	TLS Socket Authentication Error

Modem Status - 0x8A

Description

Cellular component status messages are sent from the device in response to specific conditions.

Format

The following table provides the contents of the frame. For details on frame structure, see [API frame format](#).

Field name	Field value	Data type	Description
Frame type	0x8A	Byte	
Status	##	Byte	0 = Hardware reset or power up 1 = Watchdog timer reset 2 = Registered with cellular network 3 = Unregistered with cellular network 0x0E = Remote Manager connected 0x0F = Remote Manager disconnected 0x38 = XBee firmware update started 0x39 = XBee firmware update failed 0x3A = XBee firmware update applying

Receive (RX) Packet: SMS - 0x9F

Description

This XBee Cellular Modem uses this frame when it receives an SMS message.

Format

The following table provides the contents of the frame. For details on frame structure, see [API frame format](#).

Field name	Field value	Data type	Description
Frame Type	0x9F	Byte	
Phone number		20 byte string	String representation of the phone number, padded out with null bytes (0x0).
Payload		Variable	Body of the received SMS message.

Receive (RX) Packet: IPv4 - 0xB0

Description

The XBee Cellular Modem uses this frame when it receives RF data on a network socket that is created by a TX request frame or configuring [C0 \(Source Port\)](#).

Format

The following table provides the contents of the frame. For details on frame structure, see [API frame format](#).

Frame data fields	Offset	Description
Frame type	3	0xB0
IPv4 32-bit source address	MSB 4	The address in the example below is for a source address of 192.168.0.104 . 32-bit big endian.
	5	
	6	
	7	
16-bit destination port	MSB 8	The port that the packet was received on. 16-bit big endian.
	LSB 9	
16-bit source port	MSB 10	The port that the packet was sent from. 16-bit big endian.
	LSB 11	
Protocol	MSB 12	0 = UDP 1 = TCP 4 = SSL over TCP
Status	13	Reserved

Frame data fields	Offset	Description
Payload	14	Data received from the source. The maximum size is 1500 bytes.
	15	
	16	
	17	
	18	

User Data Relay - 0x2D

Description

Allows for data to be sent to an interface with a designation of a target interface for the data to be output on. The frame can be sent or received from either of these interfaces: MicroPython (internal interface) or UART. This frame is used in conjunction with [User Data Relay Output - 0xAD](#).

You can send and receive User Data Relay Frames from MicroPython. See [Send and receive User Data Relay frames](#) in the *MicroPython Programming Guide*.

Format

The following table provides the contents of the frame. For details on frame structure, see [API frame format](#).

Field name	Field value	Data type	Description
Frame type	0x2D	Byte	
Frame ID			Reference identifier used to match TX Status frames (type 0x89) sent for errors. A value of 0 disables the TX Status frame.
Destination interface		Byte	0 = Serial port (SPI, or UART when in API mode) 2 = MicroPython
Data		Variable	

Error cases

The Frame ID is used to report error conditions in a method consistent with existing transmit frames. The error codes are mapped to statuses. The following conditions result in an error that is reported in a TX Status frame, referencing the frame ID from the 0x2d request.

- **Invalid interface (0x7c)** : The user specified a destination interface that does not exist.
- **Interface not accepting frames (0x7d)**: The destination interface is a valid interface, but is not in a state that can accept data. For example, the Destination Serial port does not have API 1 or API 2 enabled, or the MicroPython Relay frame queue is full.

Example use cases

An external processor outputs the Frame over the UART with the Micropython interface as a target. Micropython operates over the data and publishes the data to mqtt topic.

User Data Relay Output - 0xAD

Description

Allows for data to be received on an interface with a designation of the target interface for the data to be output on. The frame can be sent or received from any of the following interfaces: MicroPython (internal interface) or UART. This frame is used in conjunction with [User Data Relay - 0x2D](#).

Format

The following table provides the contents of the frame. For details on frame structure, see [API frame format](#).

Field name	Field value	Data type	Description
Frame type	0xAD	Byte	
Source interface		Byte	0 = Serial port (SPI, or UART when in API mode) 2 = MicroPython
Data		Variable	

Socket Create - 0x40

Description

Use this frame to create a new socket with the following protocols: TCP, UDP, or TLS.

Format

The following table provides the contents of the frame. For details on frame structure, see [API frame format](#).

Field name	Field value	Data type	Description
Frame type	0x40	Byte	
Frame ID		Byte	Reference identifier used to match status responses. A response is required and will be sent regardless of the frame ID.

Field name	Field value	Data type	Description
Protocol		Byte	0 = UDP 1 = TCP 4 = SSL over TCP

Socket Create Response - 0xC0

Description

The device sends this frame in response to a [Socket Create \(0x40\)](#) frame. It contains a socket ID that should be used for future transactions with the socket and a status field.

If the status field is non-zero, which indicates an error, the socket ID will be set to 0xFF and the socket will not be opened.

Format

The following table provides the contents of the frame. For details on frame structure, see [API frame format](#).

Field name	Field value	Data type	Description
Frame type	0xC0	Byte	
Frame ID		Byte	A reference identifier used to match status responses.
Socket ID		Byte	A unique socket ID to address the socket. This field is 0xFF if the value in the status field is non-zero.
Status		Byte	Status code. See table below.

The following table shows the status codes.

Code	Description
0x0	Successful open
0x22	Not registered to cell network
0x31	Internal error
0x32	Resource error: retry the operation later See Socket limits in API mode .
0x7B	Invalid protocol
0x7E	A modem update is in process. Try again after its completion.

Code	Description
0x85	Unknown error
0x86	Invalid TLS configuration

Socket Option Request - 0x41

Description

Use this frame to modify the behavior of sockets to change their behavior to be different than the normal default behavior. If the Option Data field is zero-length the request acts as a query, and the [Socket Option Response frame \(0xC1\)](#) reports the current effective value.

Format

The following table provides the contents of the frame. For details on frame structure, see [API frame format](#).

Field name	Field value	Data type	Description
Frame type	0x41	Byte	
Frame ID		Byte	A reference identifier used to match status responses. Requests made with Frame ID 0 will not send a response.
Socket ID		Byte	The socket ID to modify.
Option ID		Byte	Identifier of the parameter to change.
Option Data		Variable	Variable length field based on option type. If zero length, the current effective value will be returned in the response frame.

Options

Option ID	Option Name	Data Type	Default Value	Description
0x00	TLS Profile	Byte	0x00	Determines the TLS profile to be used: \$0 - \$2. This is valid only for TLS sockets.

Socket Option Response - 0xC1

Description

Reports the status of requests made with the [Socket Option Request \(0x41\)](#) frame.

Format

The following table provides the contents of the frame. For details on frame structure, see [API frame format](#).

Field name	Field value	Data type	Description
Frame type	0xC1	Byte	
Frame ID		Byte	Identifier provided in request.
Socket ID		Byte	The socket ID for which modification was requested.
Option ID		Byte	Identifier of the parameter requested.
Status		Byte	0x00: Success 0x01: Invalid parameters 0x02: Failed to retrieve option value 0x20: Bad socket ID
Option Data		Variable	Current effective value of the option. This field is only present if the corresponding request was a query (empty value).

Socket Connect - 0x42

Description

Use this frame to connect a socket to the given address and port.

For a UDP socket, this filters out any received responses that are not from the specified remote address and port.

Two frames occur in response:

1. [Socket Connect Response frame](#): Arrives immediately and confirms the request.
2. [Socket Status frame](#): Indicates if the connection was successful.

Format

The following table provides the contents of the frame. For details on frame structure, see [API frame format](#).

Field name	Field value	Data type	Description
Frame type	0x42	Byte	
Frame ID		Byte	A reference identifier used to match status responses. If set to 0, the device does not send a response.
Socket ID		Byte	ID of the socket to connect.
Destination port		16-bit big endian	
Destination address type		Byte	0: Indicates the destination address field is a binary IPv4 address in network byte order. 1: Indicates the destination address field is a string containing either a dotted quad value or a domain name to be resolved.
Destination address		Variable	

Socket Connect Response - 0xC2

Description

The device sends this frame in response to a [Socket Connect \(0x42\)](#) frame. The frame contains a status regarding the initiation of the connect.

Format

The following table provides the contents of the frame. For details on frame structure, see [API frame format](#).

Field name	Field value	Data type	Description
Frame type	0xC2	Byte	
Frame ID		Byte	A reference identifier used to match status responses.
Socket ID		Byte	ID of the socket that will be connected.
Status		Byte	Status code. See the table below.

The following table shows the status codes.

Code	Description
0x00	Successfully started the connection process

Code	Description
0x01	Invalid destination address type
0x02	Invalid parameter: address or port
0x03	Connection already in progress
0x04	Already connected
0x05	Unknown error
0x20	Invalid socket ID

Socket Close - 0x43

Description

Use this frame to close an Extended API socket with a specified Socket ID or to close all currently open Extended API sockets.

Format

The following table provides the contents of the frame. For details on frame structure, see [API frame format](#).

Field name	Field value	Data type	Description
Frame type	0x43	Byte	
Frame ID		Byte	A reference identifier used to match status responses. If set to 0, the device does not send a response.
Socket ID		Byte	The following options can be used: ▪ ID of the socket to be closed. ▪ 0xFF: Close all Extended API sockets that are currently open.

Socket Close Response - 0xC3

Description

The device sends this frame in response to a [Socket Close \(0x43\)](#) frame. Since a close will always succeed for a socket that exists, the status can be only one of two values: Success or Bad socket ID.

Format

The following table provides the contents of the frame. For details on frame structure, see [API frame format](#).

Field name	Field value	Data type	Description
Frame type	0xC3	Byte	
Frame ID		Byte	A reference identifier used to match status responses.
Socket ID		Byte	ID of the socket that has been closed.
Status		Byte	0x00 = Success 0x20 = Bad socket ID

Socket Send (Transmit) - 0x44

Description

A Socket Send message causes the device to transmit data using the current connection. For a non-zero frame ID, this will elicit a [Transmit \(TX\) Status - 0x89](#) frame.

This frame requires a successful [Socket Connect - 0x42](#) frame first. For a socket that is not connected, the device responds with a [Transmit \(TX\) Status - 0x89](#) frame with an error. To send data from a UDP socket that is not connect, use a [Socket SendTo - 0x45](#) frame.

Format

The following table provides the contents of the frame. For details on frame structure, see [API frame format](#).

Field name	Field value	Data type	Description
Frame type	0x44	Byte	
Frame ID		Byte	A reference identifier used to match status responses. If set to 0, the Transmit (TX) Status - 0x89 frame is disabled.
Socket ID		Byte	ID of the socket to send on.
Transmit options		Byte bit-field	Reserved
Payload		Variable	Data to be transferred to the destination, up to 1500 bytes.

Socket SendTo (Transmit Explicit Data): IPv4 - 0x45

Description

A Socket SendTo (Transmit Explicit Data) message causes the device to transmit data using an IPv4 address and port. For a non-zero frame ID, this will elicit a [Transmit \(TX\) Status - 0x89](#) frame. If this frame is used with a TCP, SSL, or a connected UDP socket, the address and port fields are ignored.

You must perform a [Socket Bind/Listen - 0x46](#) frame for a UDP connection before you attempt a SendTo in order to assign a source port.

Format

The following table provides the contents of the frame. For details on frame structure, see [API frame format](#).

Field name	Field value	Data type	Description
Frame type	0x45	Byte	
Frame ID		Byte	A reference identifier used to match status responses. If set to 0, the Transmit (TX) Status - 0x89 frame is disabled.
Socket ID		Byte	ID of the socket to send on.
Destination address		32-bit big endian	
Destination port		16-bit big endian	
Transmit options		Byte bit-field	Reserved
Payload		Variable	Data to be transferred to the destination, up to 1500 bytes.

Socket Bind/Listen - 0x46

Description

Opens a listener socket that listens for incoming connections.

When there is an incoming connection on the listener socket, a [Socket New IPv4 Client - 0xCC](#) frame is sent, indicating the socket ID for the new connection along with the remote address information.

For a UDP socket, this frame binds the socket to a given port. A bound UDP socket can receive data with a [Socket Receive From: IPv4 - 0xCE](#) frame.

Format

The following table provides the contents of the frame. For details on frame structure, see [API frame format](#).

Field name	Field value	Data type	Description
Frame type	0x46	Byte	
Frame ID		Byte	A reference identifier used to match status responses. If set to 0, the device does not send a response.
Socket ID		Byte	The socket ID to listen on.
Source port		16-bit big endian	The port to listen on.

Socket Listen Response - 0xC6

Description

The device sends this frame in response to a [Socket Bind/Listen \(0x46\)](#) frame.

Format

The following table provides the contents of the frame. For details on frame structure, see [API frame format](#).

Field name	Field value	Data type	Description
Frame type	0xC6	Byte	
Frame ID		Byte	Resource identifier used to match status responses.
Socket ID		Byte	The socket ID of the socket that has started listening.
Status		Byte	Status code. See table below.

The following table shows the status codes.

Code	Description
0x00	Success
0x01	Invalid port

Code	Description
0x02	Error
0x03	Already bound or listening
0x20	Invalid socket ID

Socket New IPv4 Client - 0xCC

Description

The XBee Cellular modem generates this frame when an incoming connection is accepted on a listener socket.

This frame contains the original listener's socket ID and a new socket ID of the incoming connection, along with the connection's remote address information.

Format

The following table provides the contents of the frame. For details on frame structure, see [API frame format](#).

Field name	Field value	Data type	Description
Frame type	0xCC	Byte	
Socket ID		Byte	The socket ID of the listener socket.
Client Socket ID		Byte	The socket ID of the new connection.
Remote address		32-bit big endian	
Remote port		16-bit big endian	

Socket Receive - 0xCD

Description

The XBee Cellular modem uses this frame when it receives RF data on the specified socket.

Format

The following table provides the contents of the frame. For details on frame structure, see [API frame format](#).

Field name	Field value	Data type	Description
Frame type	0xCD	Byte	
Frame ID		Byte	(Optional) This field allows for solicited reads to be in the future.
Socket ID		Byte	ID of the socket that the data has been received on.
Status		Byte bit-field	Reserved
Payload		Variable	Data received from the destination. It may be up to 1500 bytes.

Socket Receive From: IPv4 - 0xCE

Description

The XBee cellular modem uses this frame when it receives RF data on the specified socket. This frame is sent only for UDP sockets that have not used a [Socket Connect - 0x42](#) frame to connect, providing addressing information about the source.

Format

The following table provides the contents of the frame. For details on frame structure, see [API frame format](#).

Field name	Field value	Data type	Description
Frame type	0xCE	Byte	
Frame ID		Byte	Optional: This field allows for solicited reads to be in the future.
Socket ID		Byte	ID of the socket that the data has been received on.
Source address		32-bit big endian	
Source port		16-bit big endian	
Status		Byte bit-field	Reserved
Payload		Variable	Data to be transferred to the destination, up to 1500 bytes.

Socket Status - 0xCF

Description

This frame is sent out the device's serial port to indicate the state related to the socket.

Format

The following table provides the contents of the frame. For details on frame structure, see [API frame format](#).

Field name	Size	Description
Frame type	1	Socket Status frame type (0xCF)
Socket ID	1	Socket ID for status reported
Status	1	0x00 = Connected All values other than 0x00 = Connected are fatal and the Socket ID is closed and invalid after receipt. 0x01 = Failed DNS lookup 0x02 = Connection refused 0x03 = Transport closed 0x04 = Timed out 0x05 = Internal error 0x06 = Host unreachable 0x07 = Connection lost 0x08 = Unknown error 0x09 = Unknown server 0x0A = Resource error

File system API frames

Local File System Request - 0x3B	229
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Local File System Request - 0x3B

Description

Access the XBee module's file system.

The frame content varies based on the File System Command sent in the request. Payloads for each command and their respective responses are included.

For more information about the file system, see [File system](#).

Note The XBee modules responds to these requests with [Local File System Response - 0xBB](#).

Format

The following table provides the contents of the frame. For details on frame structure, see [API frame format](#).

Offset	Size	Frame Field	Description
0	8-bit	Start Delimiter	Indicates the start of an API frame.
1	16-bit	Length	Number of bytes between the length and checksum.
3	8-bit	Frame type	Local File System Request - 0x3B
4	8-bit	Frame ID	Identifies the data frame for the host to correlate with a subsequent response. If set to 0, the device will not emit a response frame.
5	8-bit	File System Command	See File System Commands for valid command values.
6-n	variable	Request Parameters	Variable content based on File System Command .
EOF	8-bit	Checksum	0xFF minus the 8-bit sum of bytes from offset 3 to this byte (between length and checksum). To calculate the checksum, see Calculate and verify checksums .

File System Commands

Value	Command
0x01	File Open
0x02	File Close
0x03	File Read
0x04	File Write

Value	Command
0x08	File Hash
0x10	Directory Create
0x11	Directory Open
0x12	Directory Close
0x13	Directory Read
0x1C	Get Path ID
0x21	Rename
0x2F	Delete
0x40	Volume Info
0x4F	Volume Format

Notes

- Multiple commands take a 16-bit Path ID, which allows the use of relative pathnames (using "/" as the path separator and using "." to refer to a parent directory) as command parameters. The default of 0x0000 refers to the root directory (/). See the [Get Path ID - 0x1C](#) command for details on creation and use of temporary values in order to use relative pathnames.
- For the [Directory Open](#) and [Get Path ID](#) commands, using an empty Pathname field is equivalent to using "." - both refer to the directory designated by the Path ID.
- [Request](#) and [Success Response](#) describe the frame contents starting with the **File System Command** field (and excluding the **Checksum** field).
- [Success Response](#) lists the fields following the **Status** byte when 0 (indicating a successful operation), and is only listed for commands with additional fields after the **Status** byte.
- See [Local File System Response - 0xBB](#) for non-zero (error) **Status** values in the **Response**.
- Variable-length names are NOT null terminated. The frame length determines the length of the field.

File Open - 0x01

Description

Open a file for reading and/or writing.

- Requests must have at least READ or WRITE bit set in the **Options** field.
- Use the SECURE bit (0x80) of the **Options** byte to upload a write-only file (one that cannot be downloaded or viewed). This is useful for protecting MicroPython source code on the device.

- The SECURE bit is only valid when also setting the WRITE bit and either creating a new file (CREATE + EXCLUSIVE) or replacing an existing file (TRUNCATE).

Request

Offset	Size	Frame Field	Description
5	8-bit	File System Command	File Open - 0x01
6	16-bit	Path ID	See Get Path ID - 0x1C for a description.
8	8-bit	Options	Bitfield with the following values: ▪ 0x01 CREATE: Create if file doesn't exist. ▪ 0x02 EXCLUSIVE: Error out if file exists. ▪ 0x04 READ: Open file for reading. ▪ 0x08 WRITE: Open file for writing. ▪ 0x10 TRUNCATE: Truncate file to 0 bytes. ▪ 0x20 APPEND: Append to end of file. ▪ 0x40 UNUSED: Unused, set to 0. ▪ 0x80 SECURE: Create a secure write-only file.
9-n	variable	File Name	Pathname relative to Path ID.

Success Response

Offset	Size	Frame Field	Description
5	8-bit	File System Command	File open - 0x01
6	8-bit	Status	Success - 0x00
7	16-bit	File Handle	Value used to reference file in later requests. Expires and becomes invalid if not referenced for over 2 minutes.
9	32-bit	File Size	File's size or 0xFFFFFFFF if unknown.

File Close - 0x02

Description

Close an open file and release its File Handle.

Request

Offset	Size	Frame Field	Description
5	8-bit	File System Command	File Close - 0x02
6	16-bit	File Handle	Value returned from File Open - 0x01 response.

File Read - 0x03**Description**

Read the file.

Request

Offset	Size	Frame Field	Description
5	8-bit	File System Command	File Read - 0x03
6	16-bit	File Handle	Value returned from File Open - 0x01 response.
8	32-bit	Read Offset	File position for read, or 0xFFFFFFFF to use the current position.
12	16-bit	Bytes To Read	Number of bytes to read from file, or 0xFFFF to read as many as possible (limited by file size or maximum response frame size).

Success Response

Offset	Size	Frame Field	Description
5	8-bit	File System Command	File Read - 0x03
6	8-bit	Status	Success - 0x00
7	16-bit	File Handle	Value sent in request.
9	32-bit	Data Offset	Actual offset of data read from file.
13-n	variable	Data	Data read from the file.

File Hash - 0x08**Description**

Returns a SHA256 hash to verify a file's contents without downloading the entire file. On XBee Cellular modules, there is a response delay in order to calculate the hash of a non-secure file.

Request

Offset	Size	Frame Field	Description
5	8-bit	File System Command	File Hash - 0x08
6	16-bit	Path ID	See Get Path ID - 0x1C for a description.
8-n	variable	File Name	Pathname relative to Path ID .

Success Response

Offset	Size	Frame Field	Description
5	8-bit	File System Command	File Hash - 0x08
6	8-bit	Status	Success - 0x0
7-38	32-bytes	SHA256 Hash	Hash used to verify file contents.

File Write - 0x04**Description**

Write to the file.

Request

Offset	Size	Frame Field	Description
5	8-bit	File System Command	File Write - 0x04
6	16-bit	File Handle	Value returned from File Open - 0x01 response.
8	32-bit	Write Offset	File position for write, or 0xFFFFFFFF to use the current position. If the file was opened with the 0x80 (SECURE) bit set, Write Offset must always be 0xFFFFFFFF. Secure files do not support a file seek operation.
12-n	variable	Data	Data to write to file. If empty, frame just refreshes the File Handle timeout to keep the file open.

Success Response

Offset	Size	Frame Field	Description
5	8-bit	File System Command	File Write - 0x04

Offset	Size	Frame Field	Description
6	8-bit	Status	Success - 0x00
7	16-bit	File Handle	Value sent in request.
9	32-bit	Current Offset	Current offset of file after writing Data from Request .

Directory Create - 0x10

Description

Create a directory.

Request

Offset	Size	Frame Field	Description
5	8-bit	File System Command	Directory Create - 0x10
6	16-bit	Path ID	See command Get Path ID - 0x1C for description.
8-n	variable	Directory Name	Pathname relative to Path ID . The parent directory of the directory to create must exist, for example, you must create all intermediate directories via separate requests.

Directory Open - 0x11

Description

Used with [Directory Read](#) to list files and directories in a given directory. To get a listing of entries in a directory:

1. Send a **Directory Open Request**.
2. Parse multiple entries from the **Response**.
3. If the last entry has the ENTRY_IS_LAST flag set, the listing is complete and the **Directory Handle** was automatically released.
4. If the listing is not complete, do one of the following:
 - Send a [Directory Read Request](#) to get additional directory entries
 - Send a [Directory Close Request](#) to release the Directory Handle.

Request

Offset	Size	Frame Field	Description
5	8-bit	File System Command	Directory Open 0x10

Offset	Size	Frame Field	Description
6	16-bit	Path ID	See command Get Path ID - 0x1C for description.
8-n	variable	Directory Name	Pathname relative to Path ID , or empty to get a file listing for the Path ID .

Success Response

A **Directory Open Request** sends a response identical to a [Directory Read Request](#). An empty directory returns a single entry with only the ENTRY_IS_LAST flag set, and a 0-byte **Entry Name**. A response ending with an ENTRY_IS_LAST flag automatically closes the Directory Handle.

Offset	Size	Frame Field	Description
5	8-bit	File System Command	Directory Read - 0x13 or Directory Open - 0x11, depending on request.
6	16-bit	Status	Success - 0x00
7	16-bit	Directory Handle	Value returned in initial Directory Open Response.
9	32-bit	File Size/Entry Flags	File's size in lower 24 bits, combined with the following flags: ▪ 0x80000000 (ENTRY_IS_DIR): Entry is a directory. ▪ 0x40000000 (ENTRY_IS_SECURE): File is secure (write-only). ▪ 0x01000000 (ENTRY_IS_LAST): This is the last entry. ▪ Other flags in the top 8 bits (0x3E) are currently reserved and set to zero.
13-n	variable	Entry Name	File or directory name.
<i>If there is enough room in the frame, there may be additional entries after the first.</i>			
n+1	8-bit	Null Terminator	0x00 byte to separate entries
n+2	32-bit	File Size and Flags	Refer to description above .
n+6	variable	Entry Name	Refer to description above .

Process the entries in a **Directory Open Response** or [Directory Read Response](#) as follows:

- Split the **File Size and Flags** field into separate **File Size** and **Flags**.
- Look for a null terminator after the **File Size and Flags** field.

- Extract **Entry Name** as bytes after **File Size and Flags** and before either the null terminator or the end of the frame.
- Repeat this sequence if **Entry Name** had a null terminator and the packet contains unprocessed entries.
- If the final entry of the frame does not have ENTRY_IS_LAST set, send another [Directory Read Request](#) to get additional entries.

Directory Close - 0x12

Description

The host can send this frame to indicate that it is done reading the directory and no longer needs the **Directory Handle**. Note that the **Directory Handle** is automatically closed and no longer valid after receiving a **Response** with the ENTRY_IS_LAST flag set.

Request

Offset	Size	Frame Field	Description
5	8-bit	File System Command	Directory Close - 0x12
6	16-bit	Directory Handle	Value returned in initial Directory Open Response .

Directory Read - 0x13

Description

Read entries from the directory.

Request

Offset	Size	Frame Field	Description
5	8-bit	File System Command	Directory Read - 0x13
6	16-bit	Directory Handle	Value returned from previous Directory Open Response or Directory Read Response .

Success Response

A **Directory Read Request** sends a response identical to a [Directory Open Request](#).

Get Path ID - 0x1C

Description

Many commands include a 16-bit field for the **Path ID**. If set to 0x0000, pathnames in the frame are relative to the root directory of the filesystem (/). Use the **Get Path ID** request to generate a **Path ID** for any subdirectory of the file system to allow the use of shorter relative pathnames in later requests.

- If the **Path ID** field of a Request is 0x0000, the **Response** contains a newly-allocated **Path ID** for use in later **Requests**.
- If the **Path ID** field of a **Request** is non-zero (such as one returned in a previous **Get Path ID Response**), the XBee module updates the path for that ID.
- To release a **Path ID** when no longer needed (instead of waiting for a timeout), send a **Request** with the **Path ID** and a single slash ("/") as the **Pathname**. Any **Get Path ID Request** that resolves to the root directory will release the **Path ID** and return a 0x0000 ID.
- Allocated **Path ID** values expire after 2 minutes if not used. You can refresh that timeout by sending a **Get Path ID** request with the **Path ID** and an empty or single period (".") **Pathname**.
- The full, absolute path of the **Path ID** is included in the Response only if can fit. Any code used to process the response needs to take that into account and handle an empty **Full Pathname** field.

Request

Offset	Size	Frame Field	Description
5	8-bit	File System Command	Get Path ID - 0x1C
6	16-bit	Path ID	Either 0x0000 to create a new Path ID , or an existing Path ID to update its location.
8-n	variable	Pathname	Pathname relative to Path ID .

Success Response

Offset	Size	Frame Field	Description
5	8-bit	File System Command	Get Path ID x 0x1C
6	8-bit	Status	0x00 - Success
7	16-bit	Path ID	Value to use in later File System Requests with relative pathnames.
9-n	variable	Full Pathname	If short enough to fit in the frame, the full pathname (starting with "/flash"). Deep subdirectories may return an empty field instead of their Full Pathname . The Full Pathname will never exceed 255 characters.

Rename - 0x21

Description

Rename a file/directory or move it to a new directory.

Request

Offset	Size	Frame Field	Description
5	8-bit	File System Command	Rename - 0x21
6	16-bit	Path ID	See command Get Path ID - 0x1C for description.
8-n	variable	Current Name	Pathname of file or directory to rename.
n+1	8-bit	Delimiter	A single comma (0x2C).
n+2-m	variable	New Name	New name, using a relative path to move file into another directory.

Delete - 0x2F**Description**

Delete files or a directory. The entry must delete all files in a directory before you can delete the directory.

Request

Offset	Size	Frame Field	Description
5	8-bit	File System Command	Delete - 0x2F
6	16-bit	Path ID	See Get Path ID - 0x1C for description
8-n	variable	Path Name	Pathname of file or empty directory to delete.

Volume Info - 0x40**Description**

Get volume information: used space, available space, and unusable bytes on volume.

Request

Offset	Size	Frame Field	Description
5	8-bit	File System Command	Volume Info - 0x40
6-n	variable	Volume Name	Name of volume to report on. Currently /flash is the only supported value.

Success Response

Offset	Size	Frame Field	Description
5	8-bit	File System Command	Volume Info - 0x40
6	16-bit	Status	Success - 0x00
7	32-bit	Used Bytes	Used space on volume.
11	32-bit	Free Bytes	Available space on volume.
15	32-bit	Bad Bytes	Unusable bytes on volume.

Volume Format - 0x4F**Description**

Format the space allocated to file storage. This command sends a **Volume Info Success Response** when the format completes.

Request

Offset	Size	Frame Field	Description
5	8-bit	File System Command	Volume Format - 0x4F
6-n	variable	Volume Name	Name of volume to format. Currently /flash is the only supported value.

Local File System Response - 0xBB**Description**

The XBee module sends this frame in response to a [Local File System Request \(0x3B\)](#) frame sent with a non-zero **Frame ID**. The contents of the variable-length **Response Data** field appear in the documentation for each **File System Command**.

Format

The following table provides the contents of the frame. For details on frame structure, see [API frame format](#).

Offset	Size	Frame Field	Description
0	8-bit	Start Delimiter	Indicates the start of an API frame.
1	16-bit	Length	Number of bytes between the length and checksum.
3	8-bit	Frame type	Local File System Response -

Offset	Size	Frame Field	Description
			0xBB
4	8-bit	Frame ID	Frame ID value from the corresponding Local File System Request.
5	8-bit	File System Command	See File System Commands for valid command values.
6	8-bit	Status	See Status Values for description.
7-n	variable	Response Data	Variable content based on File System Command . Only present if Status is 0 and the command has additional data to provide.
EOF	8-bit	Checksum	0xFF minus the 8-bit sum of bytes from offset 3 to this byte (between length and checksum).

Status Values

Value	Command
0x00	Success
0x01	Error
0x02	Invalid File System Command
0x03	Invalid command parameter
0x50	Access denied
0x51	File/Directory already exists
0x52	File/Directory does not exist
0x53	Invalid name
0x54	File operation on directory
0x55	Cannot delete non-empty directory
0x56	Attempt to read past EOF (end of file)
0x57	Hardware failure
0x58	Volume offline/format required
0x59	Volume full

Value	Command
0x5A	Operation timed out
0x5B	Busy (wait for prior command to complete then try again)
0x5C	Resource failure (memory allocation failed, try again)

Regulatory firmware

You can install a regulatory firmware version onto your XBee for regulatory compliance testing of your Bluetooth® and cellular radio components.

Note This firmware is to be used only for regulatory compliance testing. When you install the regulatory firmware, most XBee Cellular features are disabled, as this firmware is NOT meant to be a full-featured firmware used in production, and use of the regulatory firmware version in production is not supported.

When you install the regulatory firmware on your XBee, the current device firmware is overwritten. After regulatory testing is complete, you will have to reinstall the device firmware to return to full functionality.

The table below shows a list of features that are supported in the regulatory firmware.

Feature	Description
Firmware upgrade	Use XBee Studio or Digi Remote Manager to upgrade the device to or from the regulatory testing firmware.
Command mode	Use +++ to switch between bypass mode, DTM protocol, and other configurations.
Bypass mode	Bypass mode is available through the primary UART when configured with ATAP=5 .
USB Direct	You can configure USB Direct for use with ATP1=7 .
Bluetooth® DTM Protocol	To be able to issue DTM Commands over the primary UART, configure the module with ATAP=0 .

Install the regulatory firmware

You can install the regulatory firmware from either XBee Studio or Remote Manager.

Install regulatory firmware using Remote Manager

You can install the regulatory firmware on your XBee from Remote Manager.

Note After you have completed your testing using the regulatory firmware, you should [re-install the device firmware](#).

To perform a firmware update:

1. Download the updated firmware file for your device from Digi's support site.
 - a. Unzip the file.
2. [Log into Remote Manager](#).
3. Click the arrow next to your user name and select **Open Classic Remote Manager**.
4. In your Remote Manager account, click **Device Management > Devices**.
5. Select the first device you want to update. To select multiple devices (must be of the same type), press the Control key and select additional devices.
6. Click **More** in the **Devices** toolbar and select **More > Update > Update Firmware**. The **Update Firmware** dialog appears.
7. Click **Browse** to select the file that you unzipped earlier.
8. Click **Update Firmware**. The updated devices automatically reboot when the updates are complete.

Note The update is immediately rejected and an error is returned if the device is going into sleep mode or is being shut down. See [Clean shutdown](#).

9. When all changes are complete, [disconnect the device](#) from Remote Manager.
10. Once the regulatory firmware is loaded, configure the XBee for the testing required.
 - [Configure regulatory firmware for testing the Bluetooth® radio](#).
 - [Configure regulatory firmware for testing the cellular component](#).
11. After you have completed your testing using the regulatory firmware, you should [re-install the device firmware](#).

Configure regulatory firmware for testing the cellular component

You must configure the regulatory firmware in order to use the regulatory test commands for testing the cellular component.

Prerequisite

A SIM card must be installed in the XBee.

Configure the regulatory firmware

In XBee Studio or command mode, set the following configurations:

1. If Bluetooth® is not required, turn off Bluetooth by setting **BT**=0.
2. Disable USB Direct mode, if it is currently enabled. Set **P1** = 0.
3. Disable airplane mode, if it is currently enabled. Set **AM** = 0.
4. Configure the XBee in transparent mode. Set **AP** = 0.

Regulatory testing commands

The regulatory commands are used for regulatory compliance testing of your Bluetooth® and cellular radio components. The commands work in conjunction with regulatory firmware which you must install onto your XBee before you use these commands.

Use the commands

Before you can use these commands for regulatory compliance testing, you must do the following:

1. Install a regulatory firmware version onto your XBee. See [Regulatory firmware](#).
2. Enable test mode. See [%# \(Enable/disable test mode\)](#).
3. Start test mode. See [%1 \(Start test mode\)](#).
4. Perform regulatory tests, using the regulatory commands.
5. Stop test mode. See [%2 \(Stop test mode\)](#).
6. Disable test mode. See [%# \(Enable/disable test mode\)](#).

Regulatory command reference

As you use the commands, be aware of the following:

- After each test command [%\(1-D\)](#) the status command [%?](#) should be queried until it returns the expected result, and testing should not proceed until the module reports that it is in the desired mode. For entering [Receive Mode](#) this can take up to two minutes while the module is reconfigured. During this time, you may see the module in the error (5) state temporarily.
- If the error state persists, or the status value persistently changes between 1 and 5, double-check that the channel number ([AT%8](#)) and power ([AT%A](#)) settings are appropriate for the module and test being performed. For example, you should not attempt to use a downlink channel for the transmit test, as the cellular component will not successfully enter test mode.

%# (Enable/disable test mode)

Use this command to enable and disable test mode. When disabled, many non-regulatory testing features are also disabled, such as the ability to create sockets. For a list of the features that are available, see [Regulatory firmware](#).

Prior to enabling test mode, it is recommended that you set the module to factory default settings to ensure best results. When test mode is enabled, the module will report an [AI value of 0x31](#).

Parameter range

Value	Description
0	Disables test mode.
1	Enables test mode.

Default

Disabled

Examples

Enable test mode:

`AT%#1`

Disable test mode:

`AT%#0`

%1 (Start test mode)

Use this command to start test mode. You must perform this command at least once before you perform any other regulatory command.

Examples

Start test mode:

`AT%1`

%2 (Stop test mode)

Use this command to stop test mode. Any active test operation currently in progress is stopped.

If you do not stop test mode after you have completed regulatory testing, normal cellular component features will not be available.

Example

Stop test mode:

`AT%2`

%5 (Start modulated transmit)

Use this command to start modulated transmit using the EARFCN and power specified by [AT%7](#) and [AT%9](#).

This command works in conjunction with [%6 \(Stop transmit\)](#).

Examples

Start modulated transmit:

`AT%5`

%6 (Stop transmit)

Stop modulated transmit. This command works in conjunction with [%5 \(Start modulated transmit\)](#).

Example

Stop transmit:

`AT%6`

%7 (Set EARFCN)

Use this command to set the EARFCN (Absolute Radio Frequency Channel Number).

Parameter range

0 - 65535

This is specified in decimal to conform to standard representations found in specifications without need for translation.

Default

N/A

Examples

Set EARFCN to 5110:

`AT%75110`

Set EARFCN to 23010:

`AT%723010`

%8 (Get the EARFCN)

Use this command to get the EARFCN (Absolute Radio Frequency Channel Number) that was set using [AT%7](#).

Parameter range

N/A

Example

Get the channel number:

`AT%8`

%9 (Set transmit power)

Use this command to set the transmit power.

Parameter range

0-FFF hexadecimal

Variant range

Value is in sixteenth dBm (1/16) fixed point and is represented as a 12-bit twos-complement integer.

Default

N/A

Examples

Set transmit power to 0 dBm:

`AT%9000`

Set transmit power to -1 dBm:

`AT%9FF0`

%A (Get transmit power)

Use this command to get the transmit power value set using [AT%9](#).

Parameter range

N/A

Example

Get transmit power:

```
AT%A
```

%D (Start receive mode)

Use this command to start receive mode on the EARFCN channel specified using [AT%7](#).

Parameter range

N/A

Examples

Start receive mode:

```
AT%D
```

%I (Get channel mapping)

Use this command to get the channel mapping.

Examples

Get channel mapping:

```
AT%I
```

%? (Query test state)

Use this command to query test state.

Parameter range

Value	Description
0	Inactive (Test mode not yet started.)
1	Transition (Attempting to activate test mode.)
2	Off (Test mode started, but no active test.)
3	Receive mode
4	Transmit mode
5	An error occurred

Example

Query test state:

AT%?

Troubleshooting

This section contains troubleshooting steps for the XBee Cellular Modem.

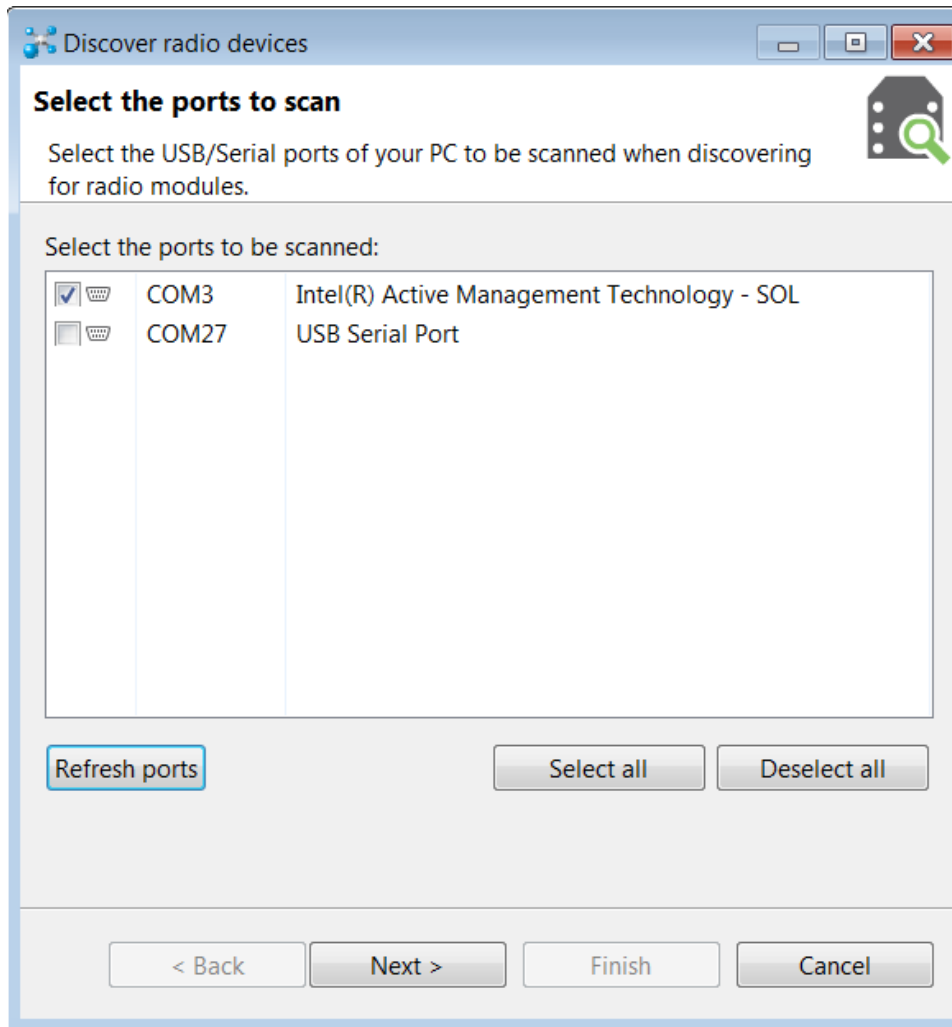
Cannot find the serial port for the device

Condition

In XBee Studio, the serial port that your device is connected to does not appear.

Solution

1. Click the **Discover radio modules** button .
2. Select all of the ports to be scanned.
3. Click **Next** and then **Finish**. A dialog notifies you of the devices discovered and their details.



4. Remove the development board from the USB port and view which port name no longer appears in the **Discover radio devices** list of ports. The port name that no longer appears is the correct port for the development board.

Other possible issues

Other reasons that the XBee Cellular Modem is not discoverable include:

1. You may not have a driver installed. If you do not have a driver installed, the item will have an exclamation point icon next to it in the [Windows Device Manager](#).
2. You may not be using an updated FTDI driver.
 - a. Click [here](#) to download the drivers for your operating system.
 - b. This may require you to reboot your computer.
 - c. Disconnect the power and USB from the [XBIB-U-DEV board](#) and reconnect it.
3. If you have a driver installed and updated but still have issues, on Windows 10 you may have to enable VCP on the driver; see [Enable Virtual COM port \(VCP\) on the driver](#).

Enable Virtual COM port (VCP) on the driver

On Windows 10 computers, if XBee Studio does not see the devices you have attached to a PC, you may need to enable VCP on the USB driver.

To enable VCP:

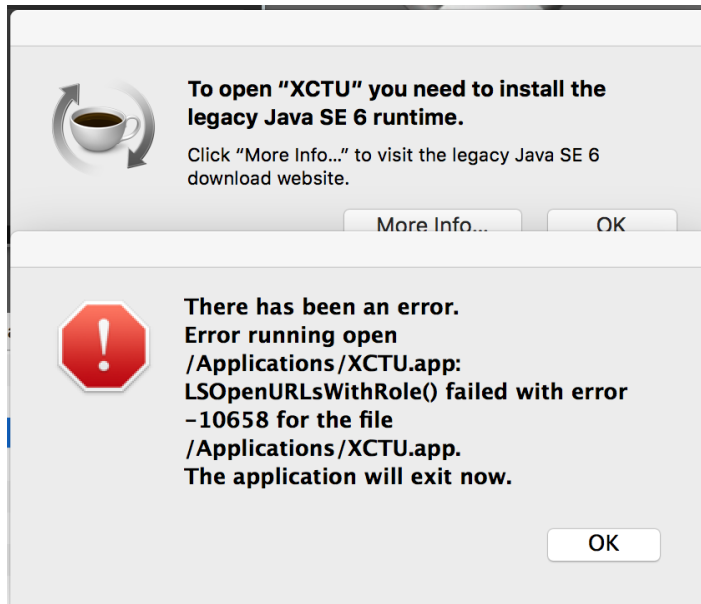
1. Click the **Search**  button.
2. Type **Device Manager** to search for it.
3. Click **Universal Serial Bus controllers**.
4. If it displays more than one USB controller, unplug the XBee Cellular Modem and plug it back in to make sure you choose the correct one.
5. Right-click the USB controller and select **Properties**; a dialog displays.
6. Select the **Advanced** tab.
7. Check **Load VCP**.
8. Click **OK**.
9. Unplug the board and plug it back in.

Correct a macOS Java error

When you use XBee Studio on macOS computer, you may encounter a Java error.

Condition

When opening XBee Studio for the first time on a macOS computer, you may see the following error:



Solution

1. Click **More info** to open a browser window.
2. Click **Download** to get the file javaforosx.dmg.
3. Double-click on the downloaded javaforosx.dmg.
4. In the dialog, double-click the JavaForOSX.pkg and follow the instructions to install Java.

Unresponsive cellular component in Bypass mode

When in Bypass mode, the XBee Cellular Modem does not automatically reset or reboot the cellular component if it becomes unresponsive.

Condition

In Bypass mode, the XBee Cellular Modem does not respond to commands.

Solution

1. Query the [AI \(Association Indication\)](#) parameter to determine whether the cellular component is connected to the XBee Cellular Modem software. If **AI** is **0x2F**, Bypass mode should work. If not, look at the status codes in [AI \(Association Indication\)](#) for guidance.
2. You can send the [!R \(Modem Reset\)](#) command to reset only the cellular component.

Not on expected network after APN change

Condition

The XBee Cellular Modem is not on the expected network after a change to the [AN \(Access Point Name\)](#) command.

Solution

Send **ATNR0** to reset Internet connectivity. See [NR \(Network Reset\)](#) for more information.

Syntax error at line 1

You may get a **syntax error at line 1** error after pasting example MicroPython code and pressing **Ctrl+D**.

Solution

This commonly happens when you accidentally type a character at the beginning of line 1 before pasting the code.

Error Failed to send SMS

In MicroPython, you consistently get **Error Failed to send SMS** messages.

Solution

Your device cannot connect to the cell network. The reason may be:

1. The antenna is improperly or loosely connected.
2. The device is at a location where cellular service cannot reach. If the device is connected to the network, the red LED blinks about twice in a second. If it is not connected it does not blink; see [Associate LED functionality](#).
3. Your SIM card is out of SMS text quota.
4. The device is not getting enough current, for example if power is being supplied only by USB to the XBIB development board, rather than using an additional external power supply.

Regulatory Information

Modification statement

Digi International has not approved any changes or modifications to this device by the user. Any changes or modifications could void the user's authority to operate the equipment.

Digi International n'approuve aucune modification apportée à l'appareil par l'utilisateur, quelle qu'en soit la nature. Tout changement ou modification peuvent annuler le droit d'utilisation de l'appareil par l'utilisateur.

Interference statement

This device complies with Part 15 of the FCC Rules and ISDE (Innovation, Science, and Economic Development Canada) license-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Le présent appareil est conforme aux ISDE (Innovation, Sciences et Développement économique Canada) applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

FCC notices

IMPORTANT: XBee modules have been certified by the FCC for use with other products without any further certification (as per FCC section 2.1091). Modifications not expressly approved by Digi could void the user's authority to operate the equipment.

IMPORTANT: OEMs must test final product to comply with unintentional radiators (FCC section 15.107 & 15.109) before declaring compliance of their final product to Part 15 of the FCC Rules.

IMPORTANT: The RF module has been certified for remote and base radio applications. If the module will be used for portable applications, the device must undergo SAR testing.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation.

If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures: Re-orient or relocate the receiving antenna,

Increase the separation between the equipment and receiver, Connect equipment and receiver to outlets on different circuits, or Consult the dealer or an experienced radio/TV technician for help.

FCC Class B digital device notice

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

FCC publication 996369 related information

In publication 996369 section D03, the FCC requires information concerning a module to be presented by OEM manufacturers. This section assists in answering or fulfilling these requirements.

2.1 General

No requirements are associated with this section.

2.2 List of applicable FCC rules

This module conforms to FCC Parts 22 and 24(cellular).

2.3 Summarize the specific operational use conditions

Certain approved antennas require attenuation for operation. For the XBee Cellular Modem, see [Antennas](#).

Host product user guides should include the antenna table if end customers are permitted to select antennas.

2.4 Limited module procedures

Not applicable.

2.5 Trace antenna designs

While it is possible to build a trace antenna into the host PCB, this requires at least a Class II permissive change to the FCC grant which includes significant extra testing and cost. If an

embedded trace or chip antenna is desired contact a Digi sales representative for information on how to engage with a lab to get the modified FCC grant.

2.6 RF exposure considerations

For RF exposure considerations see [FCC \(USA\) exposure notice](#).

Host product manufacturers need to provide end-users a copy of the “RF Exposure” section of the manual: [FCC \(USA\) exposure notice](#).

2.7 Antennas

A list of approved antennas is provided for the XBee Cellular Modem. See [Antennas](#).

2.8 Label and compliance information

Host product manufacturers need to follow the sticker guidelines outlined in [Labeling requirements for the host device: FCC and ISED](#).

2.9 Information on test modes and additional testing requirements

Contact a sales representative for information on how to configure test modes for the XBee Cellular Modem.

2.10 Additional testing, Part 15 Subpart B disclaimer

All final host products must be tested to be compliant to FCC Part 15 Subpart B standards. While the XBee Cellular Modem was tested to be compliant to FCC unintentional radiator standards, FCC Part 15 Subpart B compliance testing is still required for the final host product. This testing is required for all end products, and XBee Cellular Modem Part 15 Subpart B compliance does not affirm the end product’s compliance.

See [FCC notices](#).

Antennas

FCC (USA) exposure notice

This equipment complies with FCC radiation exposure limits prescribed for an uncontrolled environment for fixed and mobile use conditions.



This equipment should be installed and operated with a minimum distance of 20 cm between the radiator and the body of the user or nearby persons. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter except in accordance with FCC procedures and as authorized in the module certification filing.



The gain of the system antenna(s) used for SARA-U201 modules (i.e. the combined transmission line, mconnector, cable losses and radiating element gain) must not



exceed 3.42 dBi (850 MHz) and 1.51 dBi (1900 MHz) for mobile and fixed or mobile operating configurations.

Frequency band gain	Maximum
Band 5 (850 MHz)	3.42 dBi
Band 2 (1900 MHz)	1.51 dBi

ISED (Canada) exposure notice

This equipment complies with radiation exposure limits prescribed for an uncontrolled environment for fixed and mobile use conditions.



This equipment should be installed and operated with a minimum distance of 20 cm between the radiator and the body of the user or nearby persons. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter except in accordance with ISED procedures and as authorized in the module certification filing.



The gain of the system antenna(s) used for SARA-U201 modules (i.e. the combined transmission line, connector, cable losses and radiating element gain) must not exceed 0.61 dBi (850 MHz) and 1.51 dBi (1900 MHz) for mobile and fixed or mobile operating configurations.

Frequency band gain	Maximum
Band 5 (850 MHz)	0.61 dBi
Band 2 (1900 MHz)	1.51 dBi

Labeling requirements for the host device: FCC and ISED

The device shall be properly labeled to identify the product within the host device. For more information, see the [Regulatory Approvals table](#).

The certification labels of the module shall be clearly visible at all times when installed in the host device, otherwise the host device must be labeled to display the FCC ID and IC of the module, preceded by the words "Contains transmitter module", or the word "Contains", or similar wording expressing the same meaning, as follows:

Global variant	North American variant
Contains FCC ID: MCQ-XB3C2	Contains FCC ID: MCQ-XB3C2
Contains FCC ID: QIPPLS63-W	Contains FCC ID: QIPPLS63-X

Global variant	North American variant
Contains IC: 1846A-XB3C2	Contains IC: 1846A-XB3C2
Contains IC: 7830A-PLS63W	Contains IC: 7830A-PLS63X

Contains FCC ID: XPY1CGM5NNN

Contains IC: 8595A-1CGM5NNN

This Class B digital apparatus complies with Canadian ICES-003.

L'appareil hôte doit être étiqueté comme il faut pour permettre l'identification des modules qui s'y trouvent. Pour plus d'informations, reportez-vous [au tableau des approbations réglementaires](#).

L'étiquettes de certification du module donné doit être posée sur l'appareil hôte à un endroit bien en vue en tout temps. En l'absence d'étiquette, l'appareil hôte doit porter une étiquette donnant le FCC ID et le IC du module, précédé des mots « Contient un module d'émission », du mot « Contient » ou d'une formulation similaire exprimant le même sens, comme suit:

Global variant	North American variant
Contains FCC ID: MCQ-XB3C2	Contains FCC ID: MCQ-XB3C2
Contains FCC ID: QIPPLS63-W	Contains FCC ID: QIPPLS63-X
Contains IC: 1846A-XB3C2	Contains IC: 1846A-XB3C2
Contains IC: 7830A-PLS63W	Contains IC: 7830A-PLS63X

Contains FCC ID: XPY1CGM5NNN

Contains IC: 8595A-1CGM5NNN

CAN ICES-3 (B) / NMB-3 (B)

Cet appareil numérique de classe B est conforme à la norme canadienne ICES-003.

Europe (CE)

The XBee Cellular Modem has been tested for use in several European countries. For a complete list, refer to www.digi.com/resources/certifications.

If the XBee Cellular Modems is incorporated into a product, the manufacturer must ensure compliance of the final product with articles 3.1a and 3.1b of the Radio Equipment Directive. A Declaration of Conformity must be issued for each of these standards and kept on file as described in the Radio Equipment Directive.

Furthermore, the manufacturer must maintain a copy of the XBee Cellular Modem user guide documentation and ensure the final product does not exceed the specified power ratings, antenna specifications, and/or installation requirements as specified in the user guide.

Maximum power and frequency specifications

Maximum power:

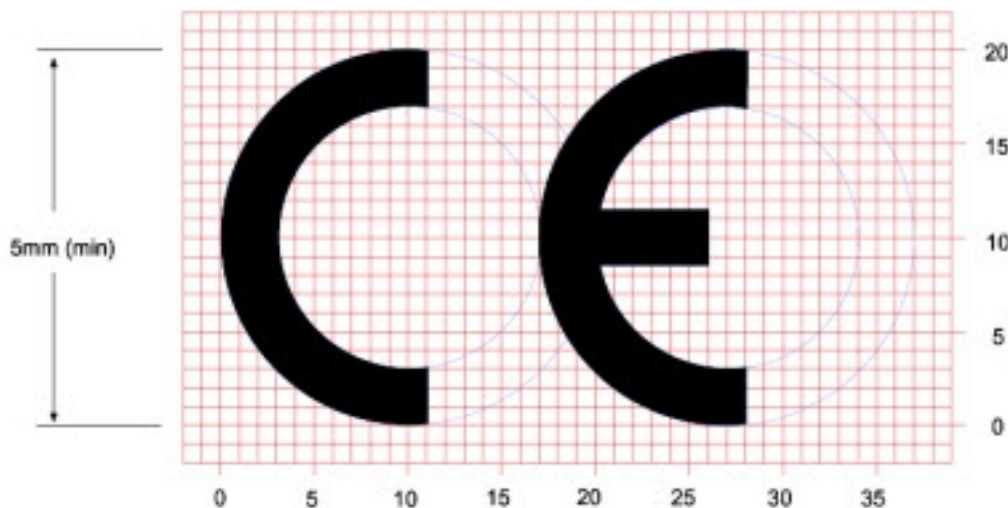
- 2 W (33 dBm) Equivalent Isotropically Radiated Power (EIRP) at normal condition.

Supported bands:

- Cellular band 1 2100 MHz UL 1920 to 1980 MHz DL 2110 to 2170 MHz
- Cellular band 8 900 MHz UL 880 to 915 MHz DL 925 to 960 MHz
- Cellular band 19 800 MHz UL 830 to 845 MHz DL 875 to 890 MHz 2 W (33 dBm)

OEM labeling requirements

The “CE” marking must be affixed to a visible location on the OEM product. The following figure shows CE labeling requirements.



The CE mark shall consist of the initials “CE” taking the following form:

- If the CE marking is reduced or enlarged, the proportions given in the above graduated drawing must be respected.
- The CE marking must have a height of at least 5 mm except where this is not possible on account of the nature of the apparatus.
- The CE marking must be affixed visibly, legibly, and indelibly.

Important note

Digi customers assume full responsibility for learning and meeting the required guidelines for each country in their distribution market. Refer to the radio regulatory agency in the desired countries of operation for more information.

Declarations of conformity

Digi has issued Declarations of Conformity for the XBee RF Modules concerning emissions, EMC, and safety. For more information, see www.digi.com/resources/certifications.

ACMA (Australia)

This certification applies to the XBee Cellular Modem.

This module complies with requirements to be used in end products in Australia. All products with EMC and radio communications must have a registered RCM mark. Registration to use the

compliance mark will only be accepted from Australian manufacturers or importers, or their agent, in Australia. In order to have an RCM mark on an end product, a company must comply with a or b below:

- a. Have a company presence in Australia.
- b. Have a company/distributor/agent in Australia that will sponsor the import of the end product.

Contact Digi for questions related to locating a contact in Australia.

RSM (New Zealand)

This certification applies to the XBee Cellular Modem.

This module complies with requirements to be used in end products in New Zealand. All products with EMC and radio communications must have a registered R-NZ mark. Registration to use the compliance mark will only be accepted from manufacturers or importers, or their agent, in New Zealand. In order to have an R-NZ mark on an end product, a company must comply with a or b below:

- a. Have a company presence in New Zealand.
- b. Have a company/distributor/agent in New Zealand that will sponsor the import of the end product.

Contact Digi for questions related to locating a contact in New Zealand.